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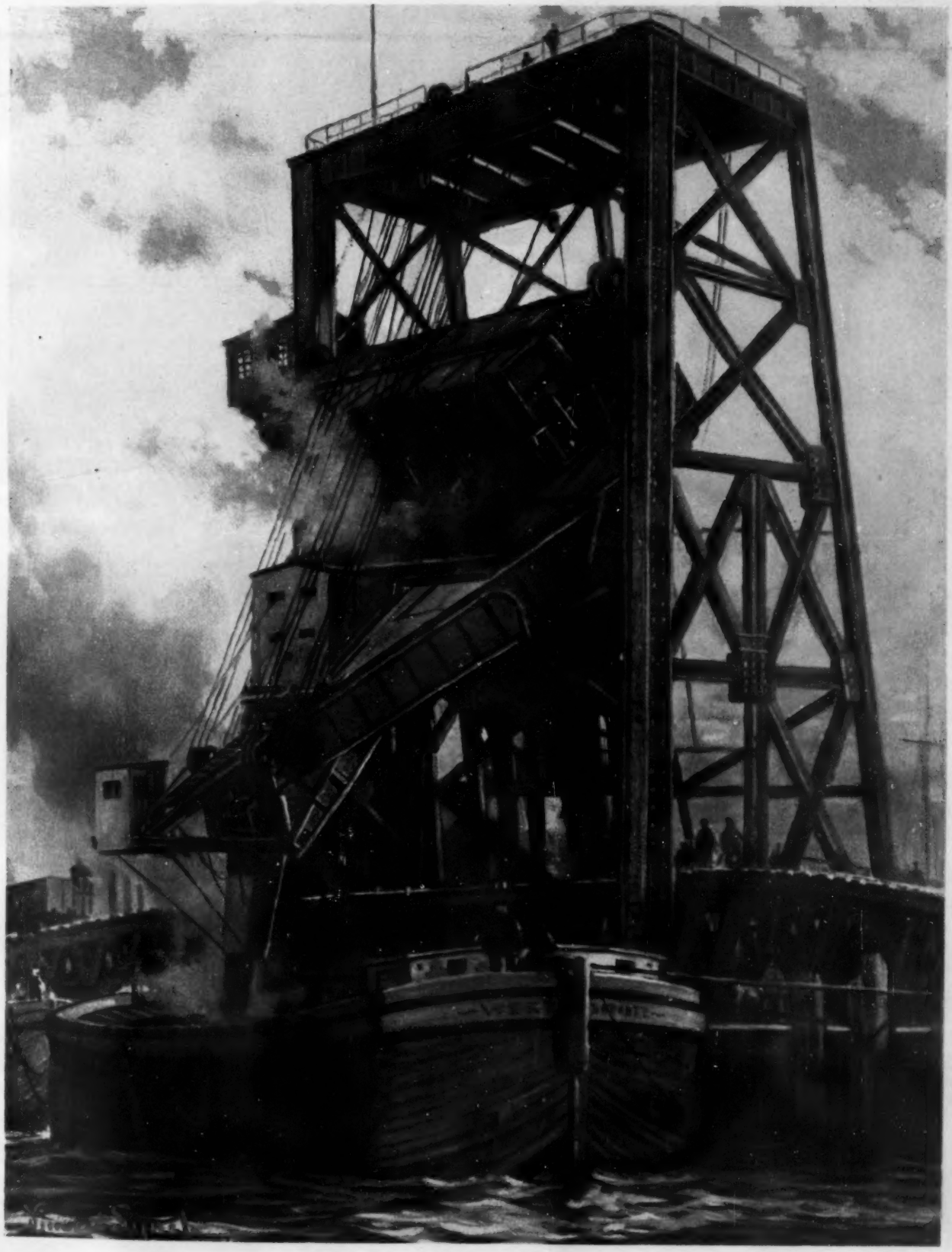
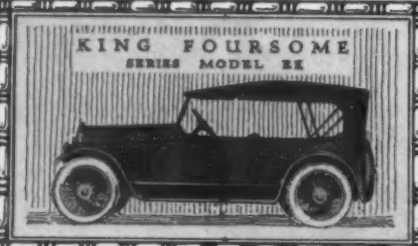


TRANSFERRING COAL FROM RAILROAD TO BARGE—A CAR DUMP IN ACTION—[See page 593]

December 30, 1916

Munn & Co., Inc., Publishers
New York, N. Y.

Price 10 Cents



ANNOVNCEMENT—1917

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SEVENTY-SECOND YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXV.] NUMBER 27] NEW YORK, DECEMBER 30, 1916 [10 CENTS A COPY $4.00 A YEAR

An Aeroplane Machine Gun that Fires Between the Revolving Propeller Blades

IT seems a mechanical anomaly that many of the battleplanes flying over the fighting forces of Europe should be equipped with machine guns that fire through the path of the revolving propeller. Yet this condition has been brought about in the development of the fast and highly-flexible battleplanes, such as the single-seater Morane of the Allies and the single-seater Fokker of the Germans.

High speed and flexibility of control are the two main requisites of a battleplane, for the victory in an aerial duel rests with the aviator having the fastest and most flexible mount, the skill of the adversaries being equal. Hence in the development of the battleplane it has been found necessary to eliminate the gunner or *tireur* whose duty was to fire the machine gun while the pilot devoted his attention to the control levers of the craft, bringing into being the single-seater fighting machine whose pilot, aside from his usual responsibilities, has to shoulder the additional duties of gunner.

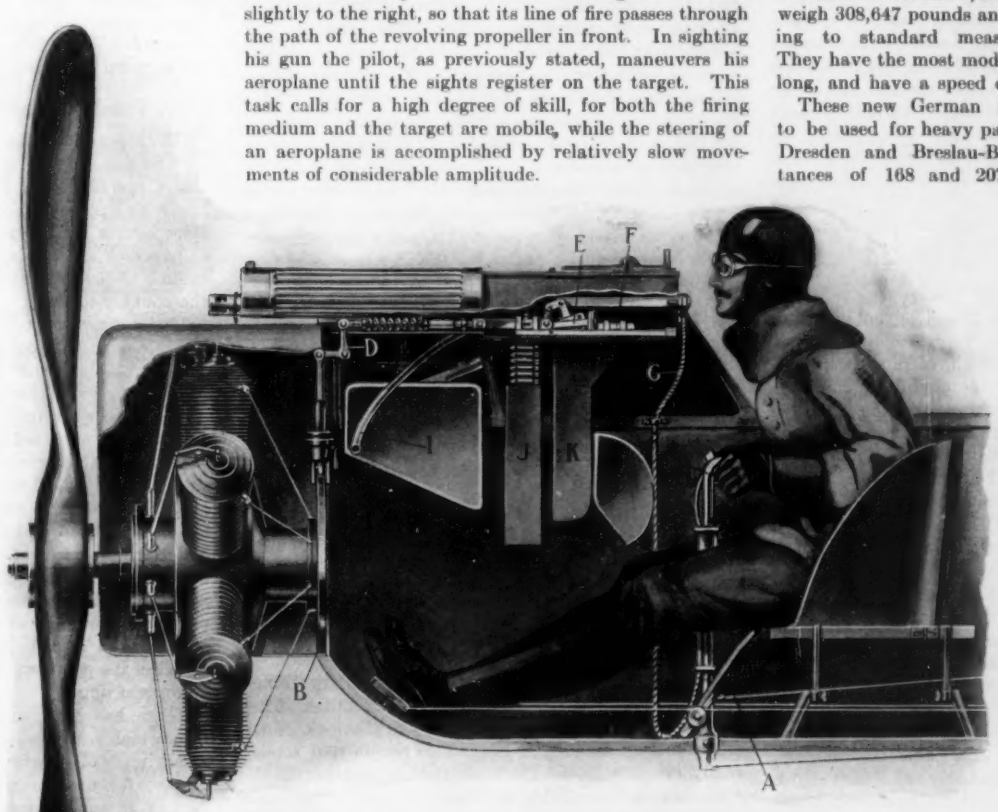
In the present-day single-seater battleplane the machine gun is usually placed in front of the pilot, above the engine cowl. Since the pilot is unable to remove his hands from the control levers for any considerable length of time, the sighting of the gun is accomplished by alining the entire aeroplane with the target, the gun being rigidly attached to the cowl. In certain of the French machines the gun is fired continuously through the path of the revolving propeller blades, no attempt being made to select such times for the firing when the blades are not in the path of fire. The portion of each propeller blade coming in direct line with the muzzle of the gun is sufficiently armored so that the bullets that strike are deflected without causing any damage, and it is estimated that under no circumstance does the wastage of fire exceed 30 per cent.

In designing their premier fighting machine, the Fokker, the Germans have endeavored to improve upon the French machines by eliminating the wastage of ammunition, not so much because of the extravagance of the wastage but because an aeroplane can only carry a limited amount of ammunition, each round of which must be made to count in a prolonged engagement. The result is found in the machine gun of the Fokker aircraft, which is automatically fired between the revolving propeller blades and without wastage of ammunition. While the majority of the Fokkers are single-seaters, by way of exception there exist a few two-seater machines equipped with a couple of machine guns, one of which is fired through the propeller while the other is mounted in the rear to give a clear sweep of the skies.

It will be noted by studying the accompanying illustration that the control mechanism of a Fokker is centered in a single post fitted with handle bars similar to those of a bicycle, supplemented by a rudder bar operated by the feet of the pilot. The elevation and depression of the horizontal rudder is effected by the backward and forward movement of the steering column, while the lateral stability of the aeroplane is maintained by the side to side movement of the post by means of the pilot's knees acting on an adjustable sliding sleeve. The seat is adjusted both horizontally and vertically.

The first move of the Fokker pilot after engaging with an enemy airman is to settle on a certain plane of flight and then lock the elevator control by means of lever *A*, so that he can then steer to right or left by the action of his feet on the rudder bar and maintain lateral balance by moving the control post with his knees; but he must continue the flight in the same plane until the elevator is again freed. This procedure permits the airman to use his hands, since they are no longer required on the handle bars.

The machine gun of the Fokker is of the Maxim type and is immovably affixed above the engine cowl and slightly to the right, so that its line of fire passes through the path of the revolving propeller in front. In sighting his gun the pilot, as previously stated, maneuvers his aeroplane until the sights register on the target. This task calls for a high degree of skill, for both the firing medium and the target are mobile, while the steering of an aeroplane is accomplished by relatively slow movements of considerable amplitude.



By means of this arrangement of a cam on the rotary engine shaft and a transmission system of levers and springs, the machine gun of a Fokker battleplane fires between the revolving propeller blades

Instead of the machine gun being fired by pulling the trigger, as in usual practice, the trigger is operated by a cam and transmission mechanism under the control of the pilot. On the revolving shaft of the rotary engine is a disk carrying a slight bulge at one point whose relation is at right angles to that of either propeller blade. The disk is indicated at *B*, while upon it rests a small wheel *C*, which receives the reciprocating movement brought about by the use of the cam member. The reciprocating movement is transmitted by a system of levers and springs, *D*, finally terminating in the piece *E*, which is hinged as shown. Normally, when the gun is not firing, the piece *E* is raised so that the reciprocating movement ends with it; but at the moment the pilot is ready to fire the gun he presses a small lever, *H*, fixed in the center of the steering bar control, which, by means of the bowden wire *G*, causes the piece *E* to be brought down in line with, and to act upon, piece *F*. The latter acts directly upon the trigger of the gun.

The action of the firing mechanism is to pull the trigger of the gun once for every revolution of the engine and propeller, at the moment when neither of the two propeller blades is in the line of fire, in spite of the high rate of revolution of the propeller which normally reaches some 1,200 revolutions per minute or 20 revolutions per second. Since the average machine gun fires anywhere from 400 to 600 rounds per minute, or 6 to 10 per second, the opportunity to fire 20 times each second is ample for the proper functioning of the gun when the engine is turning over at the usual speed. The cartridges are fed into the gun from the belt magazine *J*, the empty shells are ejected through the tube *I* which passes through the wall of the fuselage, while the empty belts are deposited in the container *K*.

A New Type of German Locomotive

AN article recently appeared in the *Breslauer Zeitung* relative to a new type of locomotive represented by engines which are making trial trips to various points from Breslau. They are provided with the three-cylinder system and are mounted on 18 wheels, 6 of which are drivers. The tenders have a carrying capacity of 7 tons of coal and 8,189 gallons of water. The engines weigh 308,647 pounds and have a driving power, according to standard measurement, of 22,046 pounds. They have the most modern improvements, are 65.6 feet long, and have a speed of 68 miles an hour.

These new German locomotives, it is stated, are to be used for heavy passenger service on the Breslau-Dresden and Breslau-Berlin runs, which are for distances of 168 and 207 miles, respectively.

Electrolysis Surveys by the Bureau of Standards.

AT the joint request of the local utility companies and the municipal authorities, the U. S. Bureau of Standards has been directing an electrolysis survey of the city of Omaha. Most of the measurements are being made by the engineers of the utility companies. Measurements are also being made under the bureau's direction in connection with electrolysis surveys at Altoona, Pa., and Baltimore. The resistance of ground connections from electric circuits is being measured by a representative of the bureau in a number of cities and towns of the country.

The Third Brazilian Fruit Exposition

ANNOUNCEMENT has just been made by the Permanent Commission in charge of Brazilian expositions that the third annual exposition-fair of fruits, vegetables, flowers, garden crops, and derived industries will be opened at Rio de Janeiro on January 28th next, and will last eight days. The federal government is taking a decided interest in the matter, so that the National Society of Agriculture, and the Permanent Exposition Commission itself, which is composed of men of prominence, is throwing all its influence into making the affair a success.

Periods of Fish Mortality on the Florida Coast

REPORTS received by the United States Bureau of Fisheries show that there were two recent periods of heavy mortality among the fishes on the west coast of Florida between Naples and Sarasota for 15 to 20 miles off shore. Outbreaks of this phenomenon, which appears to be due to natural causes, occurred on October 3d and October 18th, 1916. The beaches were lined with windrows of dead fish. Persons living in the vicinity were affected with inflammation of the mucous membrane induced by some gas, presumably sulfur dioxide, given off from the waters. There is ground for the belief that the conditions are attributable to subterranean disturbances and the release of poisonous gases which rise and pollute the waters.

SCIENTIFIC AMERICAN

Founded 1845

Published by Munn & Co., Inc., 233 Broadway, New York, Saturday, December 30, 1916

Charles Allen Munn, President. Frederick C. Beach, Secretary. Orson D. Munn, Treasurer, all at 233 Broadway

Entered at the Post Office of New York, N. Y., as Second Class Matter
Entered as Second Class Matter at the Post Office Department, Canada
Trade Mark Registered in the United States Patent Office

The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Break-Down of the Volunteer System

NO stronger argument against the paid volunteer system and in favor of universal training has been presented than is offered in the annual report of the Chief of the General Staff of the Army, Maj.-Gen. Hugh L. Scott.

He deals at considerable length with the recent mobilization of the National Guard for border service. It is evident that Gen. Scott feels very deeply over the situation which resulted, and he lays much emphasis on the break-down of the mobilization because of the difficulty in getting recruits.

Under the terms of the National Defense Act, it was expected that by the year 1920 the National Guard would consist of 17,000 officers and 440,000 men; but Gen. Scott states that in the Mexican crisis, in spite of the President's call, only 151,096 National Guardsmen were mobilized, of which on July 31st there were 110,957 on the border and 40,139 in State mobilization camps, That is to say, although the President's call should have brought 248,446 men to the border, the best that could be done, even when strenuous efforts at recruiting were attempted to swell existing units, was to get 151,096 National Guardsmen.

In what is considered by the Government a grave emergency, when the National Guard is mobilized for service on the southern frontier, to protect the lives of American men, women and children, recruiting is found to be so difficult that many of the organizations of the National Guard, although it is three months since the President's call was issued, have not yet been raised even to minimum peace strength. Furthermore, the units of the regular Army and the organized militia have not been recruited to the minimum peace strength authorized in the new National Defense Act, and this in spite of the fact that every effort has been made, even to the extent of carrying on an actual house-to-house canvas, to obtain recruits for the militia.

Gen. Scott refers to the fact that, though in May and June hundreds of thousands marched in preparedness parades amid the plaudits of onlookers, when the militia was called out in June to protect our border, it was with the utmost difficulty that its units were recruited to the small number required, some units indeed, being never filled. "The spirit was rife," says the General, "to let somebody else do it. Not only is there evidence that the volunteer spirit is moribund to-day, but the States for years have been unable to make an efficient showing with the militia, even though they were given generous assistance by the Federal government in the provision of supplies and qualified instructors."

By way of detail, the General gives figures showing the results in New York and Massachusetts. In the former State in which the militia organization was very much above the average, from August 2d to September 6th, only 351 recruits were obtained at an average cost, necessitated by the keeping up of recruiting parties, of $40 per recruit. This was the cost merely to get the man. In the State of Massachusetts, twenty recruiting stations were established; yet, between August 1st and September 25th, they enlisted only 189 recruits, at what must have been an extremely high cost.

In view of the above facts, it is not surprising that Gen. Scott should come out squarely for universal training. He gives it as his judgment that the country will never be prepared for defense until we do as other great nations do that have large interests to guard, nations such as Germany, Japan and France, where everybody is ready and does perform military service in time of peace as naturally as he pays every other tax. He is willing to make sacrifices for the protection of his native land. The General can see no reason why one woman's son should go out and defend, or be trained to defend, another woman and her son, who refuse to take training or give service.

The Scientific Man as Artist

IN reading current controversies on science teaching, controversies which have been thrown into great prominence by the war and which are mainly concerned with the relative values of science and literature in the intellectual equipment of an educated man, one is struck by the great ignorance which apparently exists regarding the very nature of science. Its practical utility is cheefully admitted, but the facts that utility is not the aim of scientific investigation, and that scientific men have not lived laborious days in order to increase the dividends of shareholders in certain manufacturing concerns, nor, it must be admitted, in order to "benefit humanity," do not seem to be generally recognized. And yet the history of any science makes these facts sufficiently obvious. On any theory except one the scientific man is a mystery. If his aim was to make money he has shown the oddest way of going about it. If his aim was to acquire contemporary renown he has been, on the whole, singularly unsuccessful. Renown which consists in a few members of a scientific society thanking Mr. So-and-so for his very able paper, and in footnote references in a few treatises which not one man in half a million has ever heard of, cannot satisfy any but a singularly anemic desire for fame. And when the fame has been of a more robust order, so that that small body of men known as the scientific world has been really excited about the matter, we get such letters as that of Newton to Leiboritz: "I have been so persecuted with discussions arising out of my theory of light that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow."

The objective of the man of science will show us what he really is, and in doing so will get rid of much pointless controversy. His aim is to obtain a widening and deepening vision of the universe; that is, he is an artist, and science is an art. The scientific man differs from the politician, lawyer, or business man in just the same way as a musical or literary artist does. His medium is different, but his aim is the same. And his incentive is the same. The governing passion in the life of the man of science is his passion for beauty. The soul of science, for the extension and embellishment of which scientific men live their lives, is the scientific theory. They do not live to invent aeroplanes, to discover wireless telegraphy, to build Zeppelins and concoct poison gases, but to see the universe as a more comprehensive and more harmonious whole, and their reward is the acute aesthetic pleasure which the discovery of such harmony entails.

It is impossible to read the history of any great scientific theory without seeing that we are here concerned with an artistic achievement, but apart from this, the very way in which scientific men refer to their work shows that their point of view is that of the artist. They are for ever talking about "this beautiful theorem," "this elegant proof"—it is always obvious that their emotions are strongly concerned. As one instance, which could be multiplied indefinitely, I quote from a letter from Faraday to Tyndall: "You are young, I am old. . . . But then our subjects are so glorious, that to work at them rejoices and encourages the feebiest; delights and enchants the strongest."

Science and art are not two complementary things, appealing to quite different intellectual faculties. They are one and the same, and both are products of the creative imagination. It is for this reason that science really consists in the scientific theory, and not in the discovery and tabulation of "Laws of Nature," still less in utilitarian applications, which, however beneficial or harmful they may be, are merely the by-products of science.

A scientific theory is distinguished from a law of nature by the fact that there is a purely imaginative element in it, a conception which cannot be expressed in terms of sense perceptions. The Newtonian Theory of Gravitation, for instance, often improperly called a law, supposes ultimate attracting particles which are not objects of sense perception. And the whole vast theory of the Ether is purely imaginative—none of our senses can give us any impression of it. A scientific theory usually correlates many laws, just as Newton's theory correlated the laws of Kepler concerning the motions of the planets, but the general acceptance of a scientific theory is not based so much upon the number of laws it correlates, as upon its success in prediction. As a mathematical consequence of Maxwell's Electromagnetic Theory, Hertz was able to predict wireless telegraphy: and an immense impetus was given to the wave theory of light when Poisson, reading Fresnel's memoir on Diffraction, saw that if the theory were true it should follow that the shadow of a circular screen should have a bright spot at the center. The experiment was made and the bright spot was found. Such discoveries are attended with a great feeling of pleasure; the motion is purely aesthetic, and arises from the spectacle of so many apparently disconnected phenomena falling into their place in a magnificent and comprehensive harmony. Mr. Balfour expressed this feeling in his Presidential address to the British Association when, speaking of the Electron Theory, he said: "The satisfaction it gives is almost aesthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river and mountain."

It is not only true that science is an art, and, to its devotees, the greatest of the arts, but in the origin of any great scientific theory we find just that personal, incommunicable, indefinable element which we find in the greatest manifestations of the literary or musical arts. There are no rules for the origination of scientific theories. Every great scientific theory was an inspired guess. Theories to correlate known phenomena may be evolved by the dozen, but the true theory, the theory which will predict, is of an altogether different order of imagination, and is as personal as the music of a great composer. There is no attempt to be paradoxical here. Insight, imagination, and even style are as apparent in scientific as in literary work. It is even possible, for those sufficiently familiar with the subject, to "spot" the scientific man by his style, just as a musician can say of a piece of music he never heard before, who composed it. There is a perfectly obvious difference in style between, for instance, the work of Kelvin and that of Maxwell, and their subjects were very similar. Self expression is as inevitable in science as in art, and whether we consider his work, his object, or his incentive, we see that the scientific man is an artist.

He dreams, and creates a universe from his dreams. Like Alfred de Vigny, he lives in an ivory tower. He is concerned with truth, it is true, but so is every artist. Keats thought truth and beauty were one, but at any rate, it is certain that, in the words of the late Henri Poincaré: There is a profound connection between the truth and the beauty of a scientific theory.

A Fundamental Element of Preparedness

IN his annual report, the Chief of the Bureau of Supplies and Accounts of the Navy, Paymaster-General Samuel McGowan, states that it will take nearly as long to authorize, build and stock the necessary store houses for Naval supplies, as it will to secure the ships which already have been authorized; a fact which cannot be too strongly impressed upon Congress and the country at large.

If the active fleet is to be fully effective, everything possible must be done during peace to perfect the system and accumulate the supplies necessary to insure the steady supply of the fleet in time of war. Everybody understands that it is too late to begin to build ships when war is declared; but it is not so well understood that it is equally dangerous to defer action on the question of supply until that date. The Paymaster-General is working on the principle that it is imperative to develop in time of peace a supply system, which, upon a declaration of war, will not require any change but merely an all-around acceleration.

Working along these lines, the Bureau seized the present opportunity to make a study of supply problems abroad, and sent to London on intelligence duty an officer of the pay corps who has wide experience in supply administration.

There has been compiled a thirty-day provision list, from which it is possible to find out at once the quantities of all items of provisions necessary for a given number of men for any length of time. By its means, cargo lists of provisions can be made up in a few minutes for the entire complement of a fleet of any size—a great advance on the old system, which consisted of first securing statements from the individual vessels of the fleet as to what was needed and then working up the supplies as they came in into an elaborate tabulation. A clothing list has been compiled and printed, showing the requirements for from 1,000 to 100,000 men, for six months, summer and winter, after they have been originally outfitted.

A thorough study of the sources of supply of fuel in time of war has been made, and plans for securing the necessary number of colliers and storage tanks have been tentatively adopted. Tests have been made of facilities at the yards for coaling and oiling battleships and destroyers under war conditions. Furthermore, in view of the difficulty of obtaining sufficient merchant ships for naval use in emergency, the ships of our merchant marine have been thoroughly investigated and the ships suitable for refueling the fleet, carrying supplies, etc., have been listed.

Finally, a study of the question of rail and water transportation has been made, and the most expeditious rail and water routes from centers of supply to points of delivery on the coast, and from Naval magazines to tidewater, have been determined. Rail facilities for the shipment of heavy guns from the Naval gun factory have been investigated and an inventory has been made of all rolling stock capable of carrying the largest guns.

Electricity

Sand Test for Detonators.—The *Collier Guardian* describes a new form of test for denotators, ordinary and electric. The charge is embodied in a bomb of suitable construction and is fitted into a mass of 100 grammes of standard sand. After the explosion the sand is passed through a series of small meshes and the degree of pulverization is taken as an index of the detonating power.

Contact in Electrotherapeutic Applications.—According to Dr. Fred H. Morse of Boston, Mass., contact is an important factor in electrotherapeutic treatments. He carefully considers the shapes and sizes of electrodes, the best material to be used, and other phases of the application. One electrode which has proved very satisfactory in his hands is made of asbestos combined with flexible copper gauze, covered with linen and with a rubber backing.

An Electric Vacuum Cleaner Worn on a Belt is among the latest offerings of the British electrical manufacturers. The vacuum fan member of the cleaner is fastened on a belt that straps around the waist of the user, the bag for the dirt hangs downward, while the suction nozzle is affixed to the end of a short length of flexible hose. Thus the user's hands are free to use the light-weight nozzle and its tube, as compared to rolling about of the usual heavy and cumbersome cleaner.

Generator in Aeroplane Radio Apparatus.—Mounted in a torpedo-shaped shell, special generators are now being constructed for wireless telephone apparatus carried on aircraft. There are two direct-current generators enclosed in the casing, one delivering low voltage for lighting the filament of the oscillating audion, while the other delivers 1,200 to 1,500 volts for the high tension circuit of the transmitter. Both armatures are mounted on a common shaft and supported at both ends on ball bearings; the shaft, in turn, is rotated by a small propeller.

Electrification of Wool.—A discovery of some scientific interest is announced by Dr. S. A. Shorter, of Leeds University, who has been working on the electrification of fibres. Hitherto it has been generally assumed that such electrification, which is a source of trouble in textile processes, is due to friction. Dr. Shorter has established the fact that electricity can be evolved as a result of drying, accompanied by a subsequent lowering of the temperature. Among the suggested methods of getting rid of such electrification are the use of metallic discharging points or of ultra-violet light. The humidification of the atmosphere has also a beneficial effect in eliminating this trouble.

Standardization of Carbon Electrodes for Furnaces.—It appears, states *The Electrician* in a recent issue, that as a result of war conditions in Germany carbon electrodes for furnaces are now being standardized. According to the new rules round carbons for steel furnaces are to be made in sizes varying in thickness from 100 mm. upwards by steps of 25 mm., the tolerance varying from 3 mm. to 6 mm. according to size. For rectangular electrodes used with other kinds of furnaces a standard size of 500 mm. square is proposed. For the time being the standard length is fixed at 2 meters, but all lengths may be valued in multiples of 20 mm. Tables for dimensions of threads are under consideration.

Electric Railway Development in Germany is the subject of an interesting article by Lord Monkswell, which recently appeared in the *Railway News*. Discussing the prospects of increased electrification, the author states that on all underground railways, in long tunnels and on steep gradients electricity is at an advantage. It has, however, the drawback that whereas an accident to a steam locomotive only stops that particular train, a failure of electric supply paralyzes the whole line. For this reason alone the German military authorities are said to have forbidden the use of electricity on railways near the European frontiers. Urban and suburban traffic in and near the great centers of population in Germany will no doubt be more and more worked by electricity, but electrification of the main lines is quite another matter, according to Lord Monkswell.

Electrical Indication of Saline Impurities in Feed Water is the subject of a recent British patent, which proposes the use of a cell in which the water to be tested forms the electrolyte. The cell is connected to an electric lighting circuit, with a lamp in series. If the liquid is pure no appreciable current will flow through the cell, hence the lamp will not light. On the other hand, the presence of even a small quantity of saline impurities renders the liquid a fair conductor, and the lamp filament glows red. A further indication is afforded by a voltmeter placed across the terminals of the cell; for with a practically pure electrolyte the reading will be slightly below the supply voltage, while the presence of impurities steadily diminishes the resistance shunted across the meter, with a resultant rapid falling off in the reading. The reading can be used as a basis for a quantitative test.

Science

Loss by Floods in the United States.—During the year 1915 the losses due to flood waters throughout the United States aggregated nearly $21,000,000. Of this amount more than half was sustained by the agricultural interests of the country.

Radium Tests at the Bureau of Standards.—During the month of October, 1916, the U. S. Bureau of Standards, in Washington, received for test a total of $77,000 worth of radium. The total value of the radium tested at the bureau up to the present time exceeds a million dollars.

Agricultural Training for Wounded French Soldiers.—The French Ministry of Agriculture has organized a special service for the agricultural training of men injured in the war. Twenty-three training centers have been opened, and the instruction given covers almost every rural industry. The injured men receive free food, lodging and tuition during the entire term of their instruction.

Aeronautical Exploration of New Guinea.—A few years ago elaborate plans were laid in Germany to explore the hitherto inaccessible interior of New Guinea by means of balloons, which were expected to drift over the island in the prevailing winds. The project was much discussed in the magazines and subscriptions were solicited in its behalf, but it was never carried out. It is now reported in the newspapers that Dr. Eric Mjorberg, a Swede, is planning to make use of an aeroplane to explore the interior of New Guinea, and is in the United States investigating the latest improvements in aviation.

"Palæolithic" and "Neolithic."—A recent paper by Prof. G. Elliot Smith urges the fact that Lord Avebury's terms Palæolithic and Neolithic, as applied to early man, have lost much of their significance in the light of present-day archæological knowledge and have become to a certain extent misleading. It now appears that the man of the Upper Palæolithic period show much closer affinity to those of the Neolithic than to lower Palæolithic man. Professor Smith proposes to distinguish between a Palæanthropic age, when Europe was inhabited by several species or possibly genera of man, whose remains have been found near Piltdown, at Heidelberg, and in the various Mousterian stations, and a Neoanthropic age, when men of the modern type, with higher craftsmanship and artistic faculties, came upon the scene.

Experiments and Investigations in Fur Farming, which have been carried on for some time by the U. S. Biological Survey, are described in the last annual report of that branch of the government. An officer of the survey spent the summer of 1915 in Alaska, studying the status and needs of fur farming in that territory. Upwards of 100 Alaskans are directly interested in the industry. There are silver-fox yards in 35 localities, while on an equal number of islands blue foxes are farmed. The silver-fox farms are not yet producing fur, but pelts sent to market during the past season from the older blue-fox farms brought good results. Experiments are being carried on at Washington, Linden, Md., and Chesterfield, N. Y., to determine the best methods of feeding, confining and otherwise handling fur-bearing animals, especially foxes, minks and martens; to determine the species most suitable for domestication; to produce improved strains by selective breeding; to investigate the effects of temperature on fur growth; and to test methods of dressing peltries and of caring for dressed furs. Animals are kept in different kinds of enclosures and fed on different kinds of food, record being kept of their condition and behavior. They are mated with reference to specific characteristics, and kept under varying climatic conditions. It is expected that eventually many kinds of fur animals, foreign as well as native, will be tested as to their adaptability to domestication.

The Status of Electroculture.—The U. S. Bureau of Plant Industry recently completed a series of experiments, extending over a period of ten years, to determine whether the electrical treatment of plants results in a stimulation of growth or an increased yield of grain. Experiments were made with wheat grown in field plants at the Arlington, Va., farm of the Department of Agriculture and in a greenhouse at Washington. In most of the experiments an insulated network suspended above the plats was kept charged for several hours each day to a high positive potential; a procedure claimed by some European investigators to give an increased yield. In addition to the direct-current experiments, rapidly alternating currents were applied to the network. The effect of the ordinary alternating-current power line attached to the network was also tried. The bureau has in preparation a bulletin giving the results of the experiments, which have now been discontinued. Briefly stated, the conclusions are that an electrostatic field has very little influence upon plant growth. In no case has a definite and positive stimulation resulted from electrical treatment.

Automobile

Protecting the Eyes.—Every automobile rider has experienced the discomfort of dust in the eyes, and also from the effects of cold winds. A suggestion has been made that these discomforts may be greatly alleviated by applying castor oil along the eyelashes. This, it is claimed, will catch most of the dust before it can enter the eye, and also it protects the eyes from the chilling effects of the wind.

Overheated Spark Plugs.—Discussions about the overheating of spark plugs are appearing in the technical papers, and while proposals for cooling plugs are commendable, it would seem that the difficulty with the offending plugs should be largely charged either to cheap and improperly designed plugs, or to the methods of the operators of the machines. Air-cooled racing motorcycles are constantly run for hundreds of miles on a stretch at 3,000 revolutions a minute, and over, without experiencing any overheating of plugs, and this clearly shows what a first class and suitable plug will stand under expert operation. If automobile operators would buy the right plugs and abandon the slipshod methods of operating that produce overheated engines we would hear less about overheated spark plugs.

Records and Tests.—Every motor car manufacturer is straining his ingenuity in devising new trials, tests and "records" to attract attention to his particular product. These are all very interesting, but the average driver neither cares to, nor is capable of performing these feats. Nevertheless, bizarre as many of these stunts appear, they contain a lesson in skilful handling that is suggestive to most car owners. The better cars now on the market are capable of wonderful performances, when properly operated and driven; and when one of them goes wrong it is usually the fault of the driver. It behooves every driver of a car to devote a little more time to the study of the mechanism of his machine, and to the proper methods of operating it under varying circumstances, both in justice to his car and for the safeguarding of his pocketbook.

Parts Substitution.—Quite a business has sprung up in manufacturing parts to fit many of the most popular automobiles, which are sold to garages and supply houses at a lower price than is charged by the builders of the cars; and while some of these parts may be equal in quality to the genuine, there is a tendency to put cheaper materials and workmanship into them, as the makers must make their profits even at the reduced price. Moreover, as these shops are not known to the general public, there is no incentive to maintain their reputation by using the best materials, and the loss falls on the buyer who has paid full price for what he supposes is a genuine article. Even where proper material is used in these substitutes there is always the possibility of undiscovered defects; and when these occur, and the buyer sends them to the car maker with a request for a replacement. the latter quite rightly declines to make good for the substitute, to the indignation of the owner. The business appears to be entirely legal, and the only remedy seems to be for the car owner who buys a part to insist on getting a guaranteed genuine part. If he buys at a cut-rate price, that should be a warning that he is not getting a genuine article, and that he takes the risk, as it is frequently difficult to get satisfaction from the garage man who has sold a defective substitute.

Carbon Deposits and a Remedy.—A writer in *The Motor Cycle* (London), discussing the cause of carbonization of the cylinder, suggests the following theory and remedy:

"As the mixture of air and minute fuel particles changes into a mixture of air and fuel vapor, the temperature tends to decrease until a point is reached at which further vaporization practically ceases, and the remainder of the fuel enters the cylinder in finely divided liquid form. When this takes place the cause of carbonization is obvious. If hydro-carbons in a liquid state are brought into contact with highly-heated surfaces, then in addition to simple evaporation a chemical change (termed "cracking") takes place, carbonaceous matter is deposited, and more volatile compounds are produced.

"If the above theory of deposit, other than that derived from the lubricant is correct, then the remedy is obvious. After the fuel has been converted into fine spray and mixed with air in the carburetor, it should be brought into contact with surfaces hot enough to complete the evaporation *before* the mixture enters the combustion chamber. This would probably be most simply effected, not as is sometimes indirectly attempted by a hot air jacket to the carburetor, but by leading an exhaust-heated pipe through the induction tube itself.

"The point where the heat energy is required is where the fuel in the form of fine spray has been mixed with the necessary air, and by proper application of this principle it should be possible effectively to vaporise the dense fuels commonly in use at present."

Making Lime from Marble

Where Tons of Stone from the Dumps Are Converted Into a Thing of Value

MARBLE was first discovered in West Rutland, Vt., in 1835. An attempt was made at that time to burn it and make lime. The efforts in that direction were unsuccessful and the lime industry gave way to quarrying. Drilling and blasting were used to get the marble out, until the Wardwell channeling machine was invented in 1863. That machine consisted of five chisels raised and dropped by hand, the force being sufficient to channel through the marble.

It will then be readily understood that at these quarries there is a large accumulation of blocks and irregular pieces of marble unsuitable for monumental or building material. There are in one pile eight thousand pieces of marble heretofore looked upon as waste or of little value. Recently, however, there has been erected in West Rutland a modern plant for the purpose of manufacturing, from these blocks, quick lime, hydrated lime and two grades of agricultural lime.

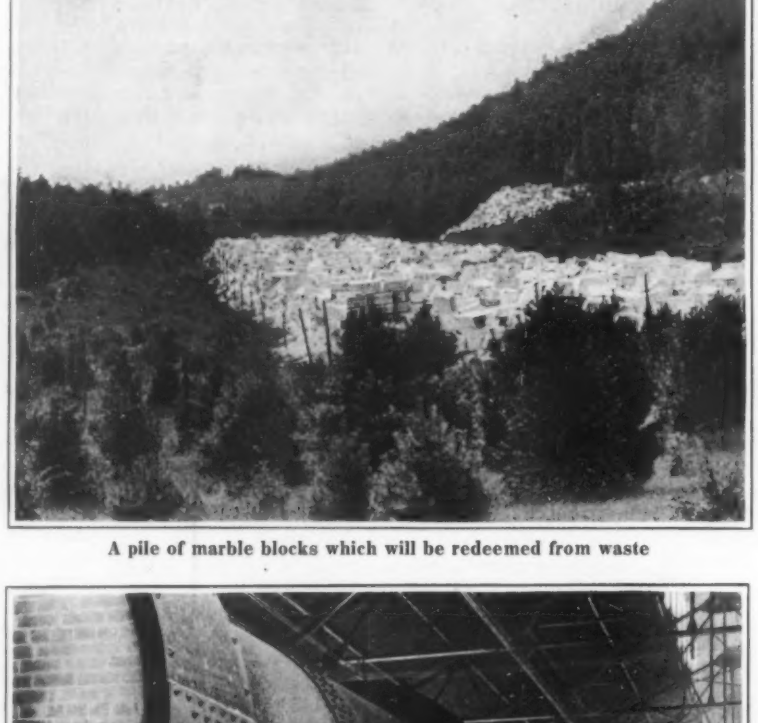
Blocks of marble weighing several tons are taken from platform cars and placed in a jaw crusher located in the end of this modern mill, where they are broken into pieces about 7 inches in thickness. These small pieces are then placed in a gyrator crusher from which they enter a roll crusher. After these crushing operations the material is placed in the cool end of a slowly revolving kiln 120 feet long, and 8 feet in diameter, in which it is subjected to a temperature of 1000 degrees Centigrade. This temperature expels the carbonic acid, leaving oxide of the lime.

As the material leaves the rotary kiln by gravity it passes to a revolving cylinder 5 feet in diameter and 50 feet long, located under the rotary kiln, where it is cooled, delivered to an elevator, screened, and placed in large tanks. In this condition it is known as quick lime. It is similar to the lump form of quick lime, but in a powdered form which is more readily mixed with other substances and possesses better keeping qualities than quick lime in lumps. From the tanks it goes through an elevator and a series of cylinders where it is mixed with a quantity of water. The material comes from the cylinders in the form of white flocculent powder; and, for the purpose of eliminating any coarse particles, it is then passed through an air separator from which it goes directly to the bags. The product in this condition is known as hydrated lime. This is used for all purposes in the building trade and for nearly all chemical processes where quick lime is used. Hydrated lime has many advantages over quick lime by reason of its purity and uniformity.

For agricultural purposes the crushed limestone is delivered by elevators to a pulverizing mill and reduced to a fine powder, the degree of fineness depending upon the process used. This product is known as crushed limestone. The tailings resulting are used for fertilizing to better advantage than the crushed limestone, as they contain a small proportion of free lime.

The building for the storage of hydrated lime in bags has a capacity of two thousand tons. The buildings are made of steel with corrugated iron roof and sides. Each machine throughout the plant is driven with individual motors, the power being furnished by hydroelectric stations and the heat being supplied to the rotary kiln by means of producer gas which is manufactured in an adjoining building specially equipped for the purpose.

A large quantity of marble, before the introduction of the rotary kiln, could not be successfully converted into lime by heat because the mass of hot marble when falling in a vertical kiln would stop the cracks between the stone and interfere with the proper draft in the kilns. This condition has been studied and is now completely obviated by the use of the rotary kiln.



A pile of marble blocks which will be redeemed from waste

The rotary kiln in which the marble is heated after crushing

Drilling the blocks and lifting them into the crusher

Where the final steps before bagging are carried out

This quarry is one of a great and continuous chain of marble concerns which are successfully operated at Rutland, Proctor, and at other points along the western slope of the Green Mountain Range in Vermont. The scope of the industry has become of such magnitude that the aggregates, both as to production and value, run into compelling figures. It is not the least important of Vermont's industrial operations.

The Vermont marble quarries, besides yielding a world-known product, have served as a foundation upon which was builded the fortunes of several generations of men, one of whom achieved national distinction.

A New Motor Fuel for Automobiles

TO be independent of gasoline as a motive power for automobiles is the dream of many an automobilist. This will be possible, at least after the war is over, if reliance may be placed in recent reports from Germany to the effect that a substitute for gasoline as a fuel for automobiles has been developed.

According to these, the German government, spurred by the growing scarcity of gasoline, ordered the technical department of the transportation service to endeavor to find a combustible which would effectively replace gasoline. Using a 1914 touring car, equipped with an ordinary carburetor, experiments were carried out on a mixture of alcohol and benzol with the following results:

Fuel	Speed in miles per hour	Miles Covered on 1 Pint of Fuel
Alcohol-Benzol mixture		
1 part benzol, 1 part alcohol	42	4.66
1 " " 2 " "	41	4.47
1 " " 3 " "	39	4.34
1 " " 4 " "	38	4.10
1 " " 5 " "	36	3.72
Benzol pure	42	3.79
Gasoline pure	44	3.60

Alcohol is easily procured; the Germans are obtaining it by distilling beets. Benzol in large quantities is now being made from coal tar in this country and Germany, but at present most of it is going into powder as picric acid. Both of these ingredients will be plentiful and cheap after the war, here and in Germany as well as in other countries.

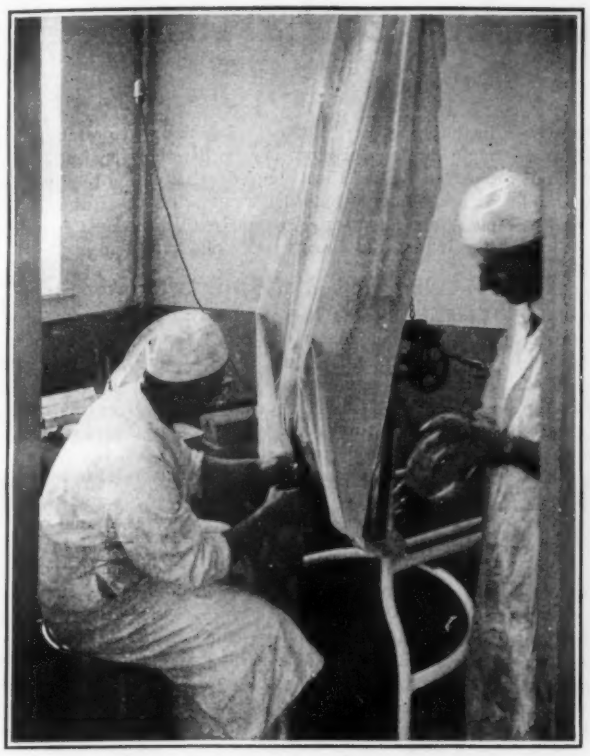
The German report states that, with alcohol figured at ante-bellum prices, the use of such a mixture is an economy. Some trouble is experienced in starting a motor with this mixture, but this has been overcome by the use of a small supplementary reservoir of gasoline, benzine or ether, the mixture being substituted thereafter. The use of this alcohol—benzol mixture in Germany is said now to be extensive.

The Projected Volga-Don Canal

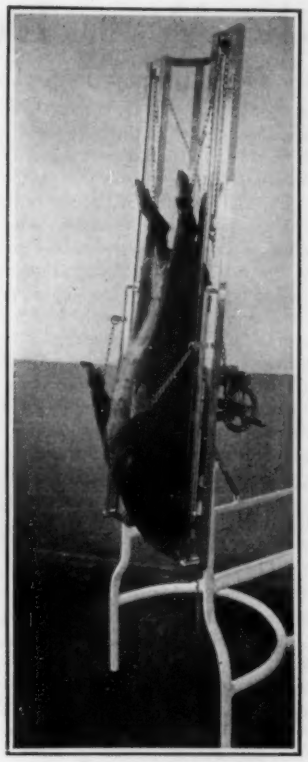
THE British acting vice-consul at Rostof-on-Don reports that, according to the local press of September 13th, the project for the construction and equipment of a Volga-Don canal, as designed by the Russian minister of ways of communications, has been approved by the government. A party of engineers has been appointed to carry out detailed technical surveys and to consider other questions connected with the execution of this large enterprise.

The projected canal will play an important part in the economic development of southeastern Russian and of the Volga and Don Basins. Grain from Tsaritsin and timber and ore from the Urals will thereby obtain a direct outlet to the ports of the Sea of Azof and thence to the Black Sea, which at the opening of the Dardanelles, at the conclusion of the war, will give access to the world's markets.

Moreover, the canal will make it possible to supply coal to all the chief cities and industrial centers of the Volga and surrounding country from the rich coal district of the Donetz Basin. It is thought that there will be a prosperous future for Rostof, which will be the outlet of the products using the new route.



Bleeding the tail of a virus hog



Virus hog ready for bleeding

Trough for holding a hog for injection

Inoculating the Mortgage-Lifters

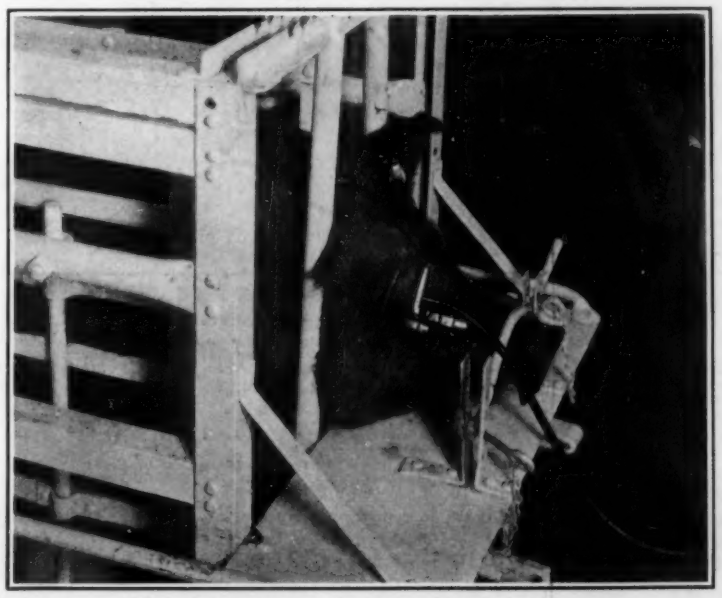
How the Disastrous Hog Cholera Epidemic is Being Controlled

By C. H. Claudy

"HOG" is a term of derision or contempt, for the man in the city. But the farmer calls his hogs "mortgage-lifters," because the revenue derived from swine raising is responsible for much of farming prosperity, and because were it not for hogs and the profit they bring, many a farm would go unimproved and undeveloped.

If one hog in a herd of a hundred dies the farmer is sorry, but he doesn't tear his hair. But if the ninety-nine die the one that is left doesn't do him much good. A thousand, a hundred thousand, even a million dollars' worth of hogs might be exterminated yearly and still there would be no great economic problem to face. But when, as happened in 1913, $75,000,000 worth of hogs die from a disease for which there is absolutely no cure—hog cholera—then indeed a wail goes up from the hog raisers.

At the present time there are 68,047,000 hogs in the United States. Their value is $571,890,000. The average loss annually, due to hog cholera, during the last forty years is estimated at not less than $40,000,000. This is altogether too large a percentage to give up in one year to a disease which, while incurable, is preventable. And while the loss in direct dollars can be estimated, the indirect loss, due to the discouragement of hog breeders, is without a price to set upon it, and no man can say what the public has had to pay because of the increased price of ham and bacon which might have been saved were hogs freed from this, their greatest pestilence.



Hyper-immunizing a hog by injection into his ear

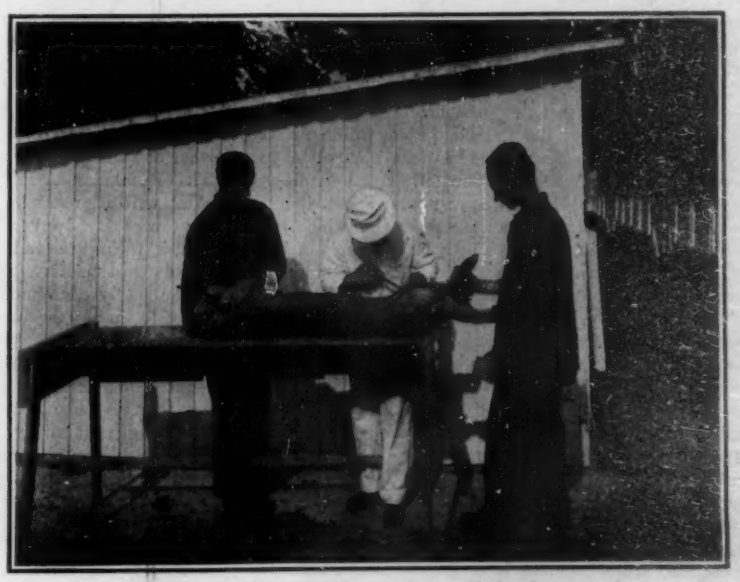
It was consideration of these things, and realization of the urgent need for assistance to those whose greatest wealth was disappearing in dead hogs, that made the Bureau of Animal Industry of the Department of Agriculture begin, in the year of greatest loss (1913), a series of experiments looking to the eventual control of hog cholera by quarantine, sanitary measures, and preventive serum treatment. These experiments extended during 1914, 1915 and 1916 to fifteen counties in Georgia, Idaho, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Tennessee, Nebraska, Missouri, Oklahoma and South Dakota.

The treatment of almost a quarter of a million hogs in infected herds has demonstrated the possibility of saving from 85 to 90 per cent of the animals. A determined effort on the part of the proper State officials, and farmers, coöperating with the Bureau, can undoubtedly control and eventually eradicate the disease.

Hog cholera is an acute febrile disease which affects only hogs. It is extremely contagious. While it is found practically all over the world, it is especially prevalent in the hog-raising districts of the United States. It first occurred in 1833 in Ohio, supposedly from imported hogs from European countries. The disease has grad-

(Concluded on page 601)

Preparing virus on a large scale



Another method of injection, using an irrigation trough

Strategic Moves of the War, December 20th, 1916

By Our Military Expert

WAR news, unless Germany's recent "peace offer" can be considered as such, has been relegated to the third and fourth pages of most of our daily papers during the past week. In my own favorite morning sheet the usual London letter, that daily leads the procession of war reports, appears in the fifth column, third page, side by side with the announcement of the startling discovery made by some ethnological highbrow to the effect that, "Eve was Adam's second wife!"

While it would be unwise to say that there can be no relation between the military situation and the political conditions created by recent events, it is also true that the attempt made by a rather large proportion of the daily press, to characterize contemporary military events as "indication of what would happen to the Allies unless they listened to the Central Power's peace offer" or "France's answer to Germany's message" is misleading and not warranted by the circumstances.

We should bear in mind that until an armistice, putting an absolute stop on all military operations, has been declared, all belligerents will continue to take advantage of any and all opportunities (creating them when necessary), to improve their respective positions, inflict losses on the enemy or deprive him of some of his territory. These are the objects for which local commanders, following the general policy of the General-in-Chief, are constantly striving, feeling here and there for a weak spot, or rather, for a spot where resistance appears to be less marked than at other places, because I do not believe that one could possibly find at this time, a really "weak spot" in either the Teutonic or Allied lines in the west. The finding of this apparently vulnerable spot is the signal for the application of terrific pressure, which is ever ready to be released at the touch of an electric button, and then we have what may develop into a "drive," provided the local command has made a correct estimate of the situation, or if he has not the other sides' war bulletins of the following day will probably account for it by stating that "yesterday, the enemy made a desperate attempt to capture our advanced position at . . . He was repulsed by our curtain fire with sanguinary losses." The side that failed will report "only lively artillery fire on the . . . sector."

It is not my intention to say that all so-called "drives" can be considered as coming within the foregoing description. We know that several of the operations that netted important gains on the Somme, at Verdun and elsewhere, were not undertaken until after several days of artillery fire preparations, and of massing of troops and accumulating great stores of supplies and munitions. I had in mind more particularly the recent German attack on Lassigny on December 14th, 1916, which the daily press told us had been made "on that part of the front nearest to Paris after great preparations, with a view to impressing the French with German success." The next day's Paris reports stated that the attack had been repulsed with great losses to the attacking forces. The Berlin reports said little or nothing about it. The German local commander probably made a wrong estimate of the situation.

We may also consider the French attack of the same date on both banks of the Meuse as being the result of a commander's desire to improve his position, acquire territory and inflict losses on the enemy. I do not believe that this was or could be preliminary to a "drive on Metz." I cannot see the possibility of a determined effort, on the part of the French, having Metz as its objective, until the Teutons have been compelled to evacuate their stronghold at San Mihiel. It will be remembered that the French have made repeated, but unsuccessful attempts to recapture this point which the Teutons had taken from them early in the days of the war, before the former had succeeded in consolidating their present line of resistance. The Teutons with their usual foresight, realized the strategic importance of San Mihiel when they seized it and have held on to it ever since. The French might be able to take it by direct assault, but the price would be prohibitive.

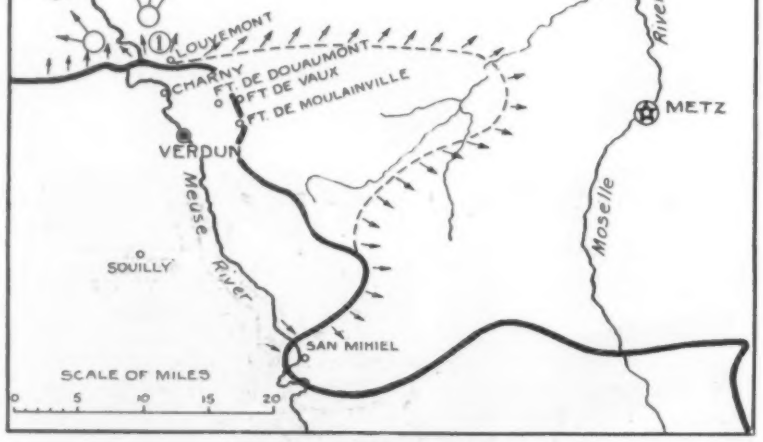
As a matter of fact, I do not believe that the French would attempt a direct drive on Metz, even if San Mihiel fell into their hands. Better and more "far-reaching" results can be obtained by attacks on both sides of the Meuse to the north and northwest from the Verdun front and to the west from the Somme front. The withdrawal of German troops from the northwest of France and from Belgium is of greater importance to the Allies' general success than the capture of Metz, even at a fair price, would be to the French cause. The former would have an almost incalculable value, with or without the latter, while the capture of Metz (admitting its possibility, which I do not, at present) without the withdrawal of the Germans from the north of France, would give the latter nothing but a sentimental advantage and place her troops in a position of great danger. A glance at the map will give a better idea of the situation. Note the German line extending east and west to the north of Verdun and the German position at San Mihiel, to the south. Note especially the narrow wedge that would be formed by the French lines advancing in the direction of Metz, and the great possibility of attacks in rear of the main advance, either from the south or from the north, or simultaneously, Note, in the event of these attacks being successful, the resulting disaster to the army finding itself cut off from its base of supplies and attacked on all sides. No, there *should* be no "drive on Metz."

There has been considerable activity on all the various sectors of the western front along the lines of so-called trench raids and bomb throwing, but apart from the French gains on the right bank of the Meuse there appear to have been no important exchanges of territory, and no serious losses inflicted by either side. Artillery duels have been of almost constant occurrence, but we have no definite reports of resulting damages. There have been but few and unimportant reports from the northeastern Russian front. The severe cold weather prohibits practically all operations in that sector. And the Italian front, too, has been unusually quiet.

There have been no reports of importance from the section north of Monastir. The Allies are probably consolidating their recent gains and fortifying their positions with a view to future contingencies. The Austro-Bulgarian forces are no doubt satisfied to await, where they are, such reinforcements as may be sent to them from wherever they can be spared, feeling quite sure that they have comparatively little to fear from the Allies as long as the situation at Saloniki remains as it has been in the past few months. With respect to this situation, we are told that the King of Greece is now willing to meet the Allies' terms. We will await further confirmatory reports on this subject.

The Rumanian Army continues to retreat and at present writing, must be well beyond the Buzeu river. Recent reports however, indicate that Russian troops are now facing the advancing Teutons. It is quite probable that this is true and that the exhausted and, possibly, badly disorganized Rumanian Army has been allowed to pass through the Russian lines and march well to the rear, where it will be reorganized, re-equipped and prepared to do its share of the fighitng. But this will take time, and I do not expect to see the Rumanian Army take its place in the fighting line much before the early part of next spring. In the meantime the Russian forces should be able to hold the Teutonic armies not far from where they are at present. This line is some-what indefinitely located from a point on the Danube near Hirsova to a point northwest of Buzeu.

It may be necessary, in view of the Teutonic activities in the upper part of the Trotus Valley, to establish the main line of resistance on the Sereth river, but this in itself would not affect the general situation to any great extent. It is thought, however, that the Russians will check the advancing Teutons within the next few days if they have not already succeeded in so doing.



Map of Operations About Verdun

The heavy line indicates approximately the location of the present lines of defense; the broken line, the probable shape of a line advancing against Metz, assuming what is improbable, that it could progress. The short arrows indicate the points where constant pressure would have to be exerted by the French in order to secure the continuity of the movement or secure the retreat of the advanced forces and prevent disaster. The ⟶ indicates the general direction of the logical line of advance from Verdun.

(1) Louvemont, the scene of recent French successes.

A New Method of Salvaging Sunken Ships

INTEREST has been aroused in Brazilian technical circles by a recent lecture at the Club de Engenharia (Engineers' Club) of Rio de Janeiro, by Dr. Sylvio Pellico Portella, concerning his invention for the salvage of sunken ships. It is claimed by him that the invention is applicable to ships sunk at almost any depth, so long as divers are able to reach them, and that it is effective in putting a wreck afloat, no matter what its position on the sea floor.

The invention consists of a tender of special model, which is equipped with floats of waterproof material. These are neatly folded, but later when inflated with air they assume all sorts of shapes—parallelopipeds, spheres, cylinders, etc. They are carried down by divers and attached to various portions of the sunken vessel, both within and without, still retaining their connection by means of hose with the tender ship. When all are properly fastened in place they are inflated by air pressure from above, like the tires of an automobile. As they swell they are said gradually to displace the water within and about the wreck, and it is claimed that by their own buoyancy they float it to the surface. It is said that the invention had two trials in Paris.

New Swedish Canal Opened to Traffic

THE Trolhattan Canal, which was opened last week, forms part of the Göta canal system of Sweden, connecting the Skagerrak at Goteborg with the Baltic at Söderköping. The value of canals was perceived in Sweden earlier than in any other European country, but, unfortunately, their construction for the most part took place before the introduction of seagoing iron freight steamers, and, according to *The Economist*, they can accommodate only vessels of very moderate dimensions—the limit of draft on the Göta canal system having been, hitherto, slightly over 9 feet. But Sweden is now tending to become not only a great exporter of raw materials, but a great manufacturing country, by virtue of the electric power afforded by its waterfalls, of which Trolhatta stands first, so that improved access from the ocean to its interior ports is becoming more important than ever. For some seven years, therefore, work has been in progress on the Göta canal system, and it is to be deepened to 16 feet and correspondingly widened, so that it will take barges, and even seagoing freighters, of some size. Factories are expected to spring up along its course and to utilize the electric power of its feeders.

The Cost of City Cartage as a Factor in the High Cost of Living

A REPORT on the preliminary survey concerning the subject of city cartage or local distribution of commodities has been made to Secretary of Commerce Redfield by Director Sam. L. Rogers of the Census Bureau. The results of this investigation, which was made in the city of Washington, confirm the general impression that the cost of city cartage is a factor of considerable magnitude in the price paid by the consumer, and, in the opinion of Secretary Redfield, justify the Census Bureau in selecting some representative city or cities and detailing experts for the purpose of making a more comprehensive study of the subject of delivery cost in relation to the prices of commodities.

For the four selected classes of merchandise covered by the preliminary survey—ice, coal and wood, milk, and department-store merchandise—representing total gross sales of about $6,000,000, the cost of delivery alone amounted to nearly $500,000, or about 8 per cent, according to the figures compiled. It is the Secretary's belief that in this single phase of cost great economies are possible; and he also believes that the survey of the selected city or cities—revealing, as it doubtless will, the very considerable proportion which the cost of cartage contributes to retail prices—will focus the attention of consumers upon the great saving to be effected by eliminating duplication and thus be of distinct aid in reducing the cost of living.

Heating a Porous House

By George H. Cushing

LAST summer a lawyer of my acquaintance urged me to write a short book—a primer—on how to heat a house. Last winter, dozens of my neighbors, who know of some results I have obtained, have made the same request. I have refused, and still do so, for one simple reason. The purpose of such a volume would be to teach how to doctor a furnace and thereby to save coal. If I did that, I would confirm the ancient idea that heating a house is solely a matter of buying and burning coal.

Instead, I am convinced that the operation of the furnace, after the house is built, is a mere detail. No amount of doctoring it or switching coals will alter the all important item—the cost of keeping the house warm. Once the house is built, the amount of fuel required to heat it is well determined. On the other hand, I am now convinced that if a house is designed and built with a few simple facts in mind, it is possible to save twenty to thirty cents a day—more than enough, in five years, to pay the difference in cost between a good and a shoddy structure.

This applies, of course, only to that part of the country, lying north of the Potomac, Ohio, and Missouri rivers, where the outside temperature for 225 days of the year ranges between sixty above and twenty below zero. I am assuming, also an inside temperature of seventy-two degrees. I am measuring the cost of raising the house temperature from what it would be to what it should be. I am convinced after studying my own and more than a hundred other houses that the secret of true comfort—and incidentally of fuel economy—is the proper design and construction of the house itself.

In a word, the cheap and satisfactory heating of a home is primarily a matter of architecture and secondarily one of construction. All efforts to save money on coal by changing from one grade to another, by doctoring the furnace, by buying smoke consumers, etc., after the house is finished smacks all too strongly of an old simile about a stolen horse and a padlock on the door of an empty stable. All last winter I tried scientific tricks upon a pile of coal to heat a house that was improperly built. I got nowhere. I learned much that coal can be made to do and much that it can't; but with all my wisdom, I couldn't actually heat a house improperly designed and poorly built.

To get the facts before us, I will start at the beginning. When I moved into this house in May, 1915, it was five years old. It is situated on a lot 135 by 175 feet and is surrounded by thirty full grown trees. On the theory that trees break the wind, it should have plenty of protection. It is, in fact, in the center of a forest one mile wide at its narrow dimension and fully ten miles long. The winter was moderate, there being no more than two weeks of zero weather with an average temperature during five months of about freezing.

I bought my coal and started my furnace fire early that fall with childlike confidence in the advice given me by a furnace manufacturer. He said that I should be comfortable all winter if I burned during the season only one ton of coal for every 100 feet of radiation in my hot water system. My house had 600 feet of radiation; this meant six tons of coal in a winter. I added a ton and a half to his estimate for good measure. That estimated seven and one-half tons of coal was gone by New Year's day and winter had not yet started.

I knew then that something was wrong and I was keen to right it. So I hunted up a fuel engineer who has made all sorts of scientific experiments for the government and various universities. He began to ask me how many windows I had; what sort of material the walls were made of; and how much inside space I had to heat. To explain why he wanted to know all this, he said:

"When you burn coal, you generate heat units. (British thermal units or B.t.u., to be scientific.) If you cut a window, you let the heat out. To overcome this loss you must generate heat units. If you have a tight wall, you keep the heat in to a certain extent but still you lose a lot of it in that way. Walls will radiate heat. If you have a loose wall, you let more of the heat out. To overcome this loss—big or little—you must generate heat units. Then after spending all this heat merely to hold your own, you still have to heat the air to be warm. It takes heat units to do that, too.

"To do these three things is why you burn coal. As you see, you create heat mainly to offset the loss by radiation through the windows, doors and walls. When you have stopped that loss, it takes little heat to warm the air inside."

Having that key to my annoying situation, I found in an engineers' almanac a rule governing such matters. It read, as nearly as I can recall, as follows:

"To offset the loss by radiation through glass in zero weather requires the generation of eighty B.t.u. per hour per square foot of glass. An average of very cold and moderately warm days in winter will demand forty B. t. u. per square foot of window glass per hour. To offset the loss of heat by radiation through the walls takes, in zero weather, sixteen B.t.u. per square foot per hour or an average for the winter of eight B.t.u. per square foot of wall per hour. To heat each cubic foot of air in the house, assuming a change of air every hour, takes one-fourth of a B.t.u. per hour."

It requires no labored arithmetic to tell that it requires a hundred and sixty times as much heat to offset the radiation through one square foot of glass as it does to heat a cubic foot of air. Also it takes thirty-two times as much heat to offset the loss by radiation through one square foot of wall as it does to heat one cubic foot of inside air. Therefore, tight windows and storm windows, and tight walls are worth while.

To indicate how any home-owner may use this rule to determine how much coal he should burn per season, I will apply it to my seven-room house. The following tabulation embodies the result.

Windows—480 sq. ft. at forty B.t.u. per hour	19,200 B.t.u
Walls—1,320 sq. ft. at eight B.t.u. per hour.	10,560B.t.u.
Inside Air—10,800 cu. ft. at ¼ B.t.u. per hr.,	2,700B.t.u.
Total, per hour	32,460B.t.u.

In one day, it requires twenty-four times that or 779,040 B.t.u. per day. Coal shows great variation. An ordinary grade of anthracite coal, such as I used, will contain about 13,000 B.t.u. per pound. But it is not possible for a furnace to yield 100 per cent of efficiency. The loss up the chimney is considerable; the loss by radiation through the sides is an item. Therefore, in practice, of the heat generated in the furnace, it is conservative to expect to get the use of 60 per cent. For that reason, instead of a possible consumption of coal of 60 pounds per day, I should have burned not more than 100 pounds of coal per day.

Last year, the cold weather came late. This year, the spring came early. So the furnace was needed only during 190 days, which was accounted for, in part, by the fact that the house was closed for a month. So, even with all the windows, I should have burned only 9½ tons of coal if the theory is correct—however, theory went to protest in my case; I burned, as related, 18 tons of coal. And the house temperature was not the theoretical seventy degrees which my figures anticipate, but more nearly an actual average of sixty-five. It was practically impossible, in a word, to heat the house.

Analyzing, after the experience—as most of us are prone to do—I concluded that the man who built the house had tried the common thing; he had attempted to limit the first cost. I do not say it was a house built only to sell and hence shoddy. Rather, he feared to make good enough for himself lest it prove too good for the man who might want to buy it. When once started upon a policy of sparing original expense, there was no logical place where he could quit. Thus, he bought a furnace that was two sizes too small. This saved him less than fifty dollars. When I fell heir to this furnace mistake, I found that the fire had to be forced all the time. This burned coal much faster than home needs demand and yielded no natural result but waste. Indeed my yearly excess fuel bill is nearly double what the builder saved on this item.

A similar effort at economy omitted the secondary damper from the chimney or the smoke pipe. That is, the only one installed was a part of the furnace. Thus, when the wind blew there was no way to put a double check on the draught without shutting it off almost entirely. As a result, the consumption of coal doubled but the heat escaped up the chimney without stopping to heat the water. To be specific, I burned one Sunday 300 pounds of coal instead of a normal 125 pounds, but the temperature of the water rose only five degrees. I might say that an ordinary damper to check this loss costs but ten cents and the most expensive damper I have found costs but five dollars.

The defects in the construction were even more serious. As has been indicated, this seven-room house has an unusual number windows—forty in all. When the loss of heat through glass is recalled, this makes an expensive heating proposition at best. To make matters worse, the arrangement of them was bad. The south side, where the sun shone and where a certain amount of protection was afforded, is practically a dead wall. It has few windows. The north side, where the wind is strong and where no sun enters, is practically all glass. To make it worse, those windows are of the "artistic" kind. They are casement windows made of spongy wood. In wet weather they can be neither shut nor opened. In dry weather they touch the sill only at the hinges. As a result, in winter they leak air into the house in veritable gales. To make them still more "artistic" they are latticed. The builder may have had an eye for beauty, but he was not careful to see that the joints between the wood and the glass were sealed with putty. This made a secondary air leakage.

In construction, the house was stucco on frame. The stucco apparently had been put on without using a proper mixture of sand, cement and gravel. This is one thing that is almost sure to happen when one starts to save money on first cost. The result was that even the walls leaked air. This, of course, added to the loss of heat.

Having entered upon a catalog of the demerits of this house for a purpose, I will not overlook the principal one. The effort at "artistic" designing became a conscious struggle to defy every tradition and to eliminate every feature which has the sanction of time. Thus, every interior door downstairs was banished, save one which segregated the kitchen. It is not possible, therefore, to close off any cold room and thus protect the rest of the house. On the contrary, everything is wide open. There isn't even a door to close the stairway. As a most natural consequence, every inrush of air at any cold point makes itself felt all through the house and destroys all efforts to heat it evenly and effectively. As a matter of fact, on cold days the family had to segregate itself in the upstairs sitting room and summon the aid of a gas stove to help out the furnace.

All these things help to explain why I burned 8½ tons of coal more than I should in a mild winter; why I paid $74.80 more for fuel than was necessary; why my house was always cold. They indicate, I believe, that the proper time to study fuel economy is not after the house is built and the cold weather is upon one, but when the house is being built.

Unloading Coal Cars by Turning Them Upside Down

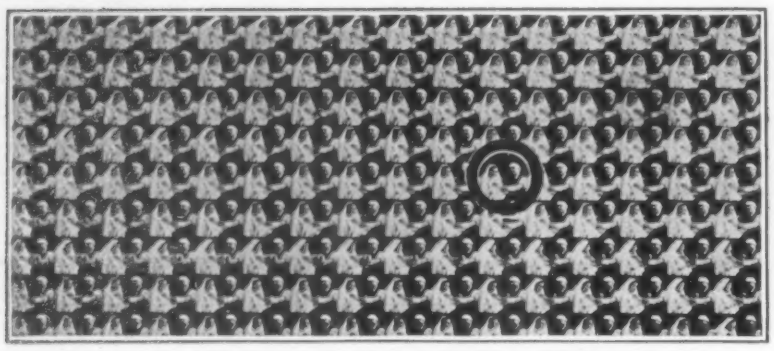
IN the handling of coal the high wooden trestle is steadily giving way to the modern car dump, which picks up the heaviest coal car and turns it almost upside down so that its contents can pour out and pass through a chute into the hold of a waiting barge or freighter. The first dumps did little but turn the car over and empty it into an apron, where the coal ran down into buckets which, in turn, were emptied into the hold of the vessel in due course. The main objection against these pioneer dumps, of course, was their inability to handle the enormous quantities of reshipped coal of a later period; but an almost equally serious objection was to be found in the numerous handlings, which resulted in the excessive breakage of the coal. So with the advent of the modern vessel hatch, which is so large that the vessel seems to be practically all hatch, little time was lost in introducing the present car dump, of which there are between 50 and 60 in use in various places throughout the world at present.

In the case of a typical car dump installation, the trains of loaded cars of the proper classification of coal are brought in as required, and these are pushed over a hump about 1,800 feet from the car dumper to service storage tracks on a grade between 1.4 and 1.8 per cent toward the dumper. When the brake is released, the car then descends by gravity, passing over the haulage-car pit to a streten of level track about 175 feet from the dumper. The haulage car, which is controlled by the haulage engine, ascends the curved track from the pit to where the narrow-gage track is on a level with the main rails before engaging with the loaded car. The narrow gage track referred to is placed between the rails of the standard-gage track entering the loading end of the dumper, and at the bottom of the grade leading to the dumper is a pit into which the haulage car descends on a vertically-curved track to a depth sufficient to take it entirely below the level of the main rails. The haulage car is employed to push the coal cars, one by one, up the 10 per cent incline leading to the car dump and onto the platen rail. As the car is being raised into the dumping position, it is automatically clamped to the cradle. In the usual installations the car is turned through an angle of 135 degrees, and it is often necessary to rock the car back and forth a few times to empty it entirely. In some of the newer machines the car is turned through an angle of 160 degrees, insuring the entire discharge of the cargo at one operation. Several hundred horsepower is necessary to operate the dumper proper.

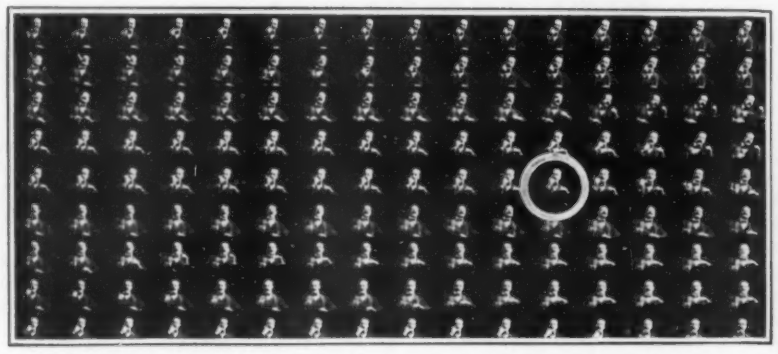
The emptied car is then returned to its original position by the lowering of the cradle, and the next loaded car, pushed into place by the haulage car, shoves the empty off the platen onto an incline. The empty descends by gravity a grade corresponding to that entering the dumper, and runs up a 25 per cent incline to a kick-back.

Meanwhile the coal, which has been dumped into an apron of triangular form, passes down the funnel-like container to the telescopic chute through which it is delivered to the waiting barge or freighter. The pan is so hinged that it may be swung up to position almost parallel and close to the face of the dump in order to clear the rigging and other obstruction on the boat, and it is also carried on vertical screws to allow raising and lowering to accommodate boats of different heights.

Being telescopic in form and so hung as to allow swinging in any direction, the spout from the pan permits of distributing the coal in the boat with little breakage. The chute is moved about into any desired position by means of a 35-horsepower motor, and the necessary transmission mechanism is located near the end of the pan. The movements of the chute are controlled by an operator who, sitting in a cab carried by the pan, has a clear view of the spout and hatchways at all times. The normal capacity of such a chute is about forty cars an hour, but this capacity has been increased up to one car per minute for a short period, and on one occasion 90 cars were handled in 95 minutes.



Negative No. 1. This is only a small section of the original negative which contains over 500 images of the two subjects



Negative No. 2. Here the subject is chatting and smoking, while the camera has been recording his moves every twelfth of a second

Motion Picture Portraits

Selecting One's Photographs from Over Five Hundred Poses Taken at a Sitting

BY applying the principles of motion pictures and of modern enlargements on paper, Mr. G. Bettini of New York City has evolved a new system of photography which is revolutionary in many respects. The inventor states that all the expensive apparatus in the professional studios will be unnecessary when his camera is introduced, and in portrait work, because of the certainty of natural expression selected and the simple manner of controlling the light effect, the average amateur will be able to make artistic portraits quite as readily as the foremost professional.

The new process consists of nothing more than the taking of motion pictures of the subject while the latter is assuming a number of natural poses, then developing the negative and printing a positive from it, followed by the projection of the positive for the subject so that a selection of poses may be made, and finally the printing of the desired photographs on paper to any size desired.

For his photography Mr. Bettini depends upon a motion picture plate camera similar to that for home cinematography, described in the SCIENTIFIC AMERICAN, of November 11th, 1916. At the rate of about twelve per second, the various poses assumed by the subject are photographed on a standard glass plate negative in horizontal and vertical rows, the plate being sufficiently large to take something like 500 or more exposures. Each exposure or image is ¼ or ⅜ inch square, the former dimensions being that of the existing camera, while the latter will probably be that adopted for the commercial cameras. When the camera has recorded the series of poses, the negative is removed from the light-proof magazine and developed in the usual manner.

A positive glass plate or lantern slide is then made from the negative, and the subject then has an opportunity of seeing himself on the motion picture screen, just as others see him. Since the glass plate is non-inflammable, the subject can have the motion picture projector stopped at any desired point. Thus a selection is made of one or more poses, and by means of two indices—one for the horizontal and one for the vertical rows—the operator can make a note of the images approved of.

The photographer then returns to the negative, which he places in an enlarging machine. The latter, in its main essentials, is a counterpart of the projector; in fact, the projector may as well be employed for this purpose if there is no occasion to use both machines at one time. Referring to the notations of the poses selected, the photographer brings the desired image into position by adjusting the pointers on the horizontal and vertical indices which correspond to those on the projecting machine. The enlarging process now resolves itself into the usual procedure: the powerful arc lamp is turned on, a piece of plain paper is placed on a stand in the path of the rays of light, in order to focus the negative image properly; and finally the sensitized paper is substituted for the plain paper and the exposure made

Because of the tremendous enlargement which is occasioned by the employment of so small a negative for so large a print—7¼ by 9¼—the inventor has had to overcome the appearance of prominent grain in the print, particularly when fast plates are employed. Mr. Bettini has solved the problem by causing the rays of the enlarging machine to pass through a piece of silk bolting cloth, held between two sheets of glass, just behind which is placed the sensitized paper. The fine screen thus interposed effectually destroys all traces of the coarse graining, and its mesh is barely discernable in the enlargements. Naturally, the screen necessitates a longer exposure for the paper, but this is not a troublesome feature to contend with when one is dealing with seconds.

The finished prints made by the new process have the soft, harmonious effect that is so much in vogue among leading photographers to-day, and despite the intense enlargement the amount of detail demanding attention is surprisingly high

But most commendable of all is the naturalness—

Enlargement made from the image marked by a white circle in negative No. 2

unusualness, one might say, since naturalness is such a rarity in studio photographs—of the expressions and poses, for the subject has been photographed at moments when these were beyond voluntary posing. Finally, it should be remembered that in this new process the subject is not obliged to assume a number of expressions and poses under the guidance of the photographer; instead, he smokes, laughs, reads a letter, and chats with the photographer while the camera is recording every move that he makes. "Painless photography" is what we are tempted to call it.

Enlargement made from the circled image appearing in negative No. 1

Types of Musical Instruments Used in Siam

MUSICAL instruments of occidental types have not yet become very popular in Siam. The piano and the small portable organ may be seen occasionally in the homes of the Siamese and Chinese, but they are kept for ornamental rather than actual use. Some other instruments of foreign make, however, have found favor for use in military bands and in the funeral processions of the Chinese. The phonograph has a place in every Siamese or Chinese home that can afford one; in fact, a strong demand exists for phonographs and phonograph records.

The Siamese musical scale has been described as radically different from the European. The ideal scale in Siam is an equal division of the octave in seven parts, and each interval therefore, consists of 1⅐ semitones. The Siamese music is not written but learned by ear and handed down traditionally.

In his book, "Lotus Land," Mr. Thompson, describing Siamese orchestral music, states that in an open-air band the conductor sits within a large circular frame, from which are suspended small gongs of different tones. On either hand are the "ranats" or harmonicons, consisting of strips of bamboo strung upon a sort of cradle, and tuned by small weights stuck upon them with wax. The cradles are sometimes beautifully inlaid with ivory. When an actor in a theatrical performance begins to sing, the conductor of the orchestra softly follows the first long-drawn-out notes until he hits upon the correct key. This he gives to the rest of the band, and then the liquid notes of the "ranats" join in.

In the full band, which plays at a rich man's house on great occasions, stringed instruments also are used. The oldest of these are viols, quite similar to those used in Persia. The belly of the instrument is made of the dried outer rind of a cocoanut, covered with fish skin, upon which is fastened a piece of colored cut glass, serving apparently to quench the inharmonic proper tones of the membrane. The foot is of turned ivory and the neck, also of ivory, is enriched with niello-work, or inlaid mother-of-pearl. There is no finger board. The three strings are of silk cord, and the bow is strung with horsehair. There are small fiddles of a Chinese pattern, with two strings and a belly which looks like the bowl of a pipe.

The laos of northern Siam have a very interesting reed instrument, which is made up with fourteen bambo or hollow-reed pipes symmetrically arranged with a small air chamber and mouthpiece of turned wood or ivory. A tongued metal plate is inserted in a slit in each pipe, and the joints between the pipes and the air chamber are stopped with wax. The tone of this instrument is described as peculiarly sweet, and chords may be produced upon it.

Among the highly prized instruments of Siam are the "frog" drum and the chank shells, which are considered of good omen and form part of the ritual band that furnishes the music when the king honors state ceremonies with his presence.

Siam has no stores where rare native musical instruments may be purchased, and it is only occasionally that one may be found for sale in a pawnshop. Modern musical instruments, including phonographs and records, are sold by all the leading general stores in Bangkok.

While the natives are supposed to cling steadfastly to established custom, the sales of foreign-made instruments show that they have broken away from precedent.

Arabian Capital of Egypt Laid Bare for the First Time

THE pictures which we present herewith afforded, on their recent arrival in New York, the first indication which has reached this side of the ocean of the fact that excavations of the highest importance have been progressing near Cairo since the war broke out. The location indicated by the general view showing the mosque in the background, is one well known to the leading Egyptologists in this country, but one in which at last accounts a beginning of digging had yet to be made.

Explanation of this unlooked for activity is probably to be found in a statement accompanying the photographs, to the effect that this work has been proceeding under the supervision of M. Ali Bahgat, Director of the Cairo Arabic Museum. When American scientists were last in Egypt, this office was held by an Austrian, M. Herz Bey. It is assumed that this gentleman was disposed of by the British Administration and M. Baghat, his native assistant for some time past, elevated to the post. Whether the new director's prompt prosecution of this bit of excavation was due entirely to his own zeal, or whether it had risen from a desire to give employment to German prisoners of war, cannot be said; but in view of the excavations carried on in this way upon the Roman cities of Algeria and Morocco, the latter suggestion is far from an improbable one.

The choice of the site for this work was a very happy one, inasmuch as it marks the first work done in recovery of relics of the long Arab occupation of Egypt. This began in 641, with the capture by the Arab general Amr ebn el-Asi of Babylon, the old Roman fort near Cairo, and which is not to be confused with the one-time Mesopotamian metropolis of the same name. The conquerors established themselves here, and their headquarters became known as Fostat, from the Latin *fossatum*, surrounded by trenches. For five centuries Fostat was the seat of Arab control in Egypt, and waxed rich and luxurious. Destroyed by fire in 750, it was rebuilt, according to the custom of earlier days when it was found easier to establish a new site than to clear the old one, at a point just north of the old town. The latter was gradually lost to sight and memory, and is now brought to light for the first time.

An extraordinary wealth of material pertaining to the Arab and of course to the preceding Roman periods of Egyptian history is indicated by our illustrations. There have been laid bare house skeletons with stone staircases almost intact, old mills practically in their original state and oil presses galore. The human element so often furnished in this connection by thumb-prints which have outlived their makers by thousands of years are to be found, not alone on pieces of pottery, but in the clay piping of public and private baths. Loom-sites are also frequent; for while wooden frames from bygone ages are never found to have withstood the ravages of time, the old Egyptian custom of seating the weaver in a large depression in the floor, with small holes to support the loom upright before him, makes it easy to identify the spots where weaving has been done.

The array of pottery which we picture shows a hit-or-miss admixture of the long thin Roman vessels, tapering at the bottom and with more or less elaborate necks and handles, and the severely simple Arab productions which at the most are elaborated only to the point of possessing a very rough, short circular spout. With the tendency of the times to link up everything with the war, an effort has been made to identify these latter, as shown grouped in the center of our cut, with the (hypothetical) vessels in which it is asserted that the Greek Fire was hurled, and thus to establish them as the lineal ancestor of the modern hand grenade. This, of course is quite absurd; the vessels in question are neither more nor less than containers for the olive-oil produced by the presses mentioned above, and which formed the staple item of Egyptian commerce of the period.

Relics of the Roman and Arabic periods unearthed in Egypt's old capital

General view of excavations now in progress near Cairo

The Current Supplement

IN the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2139, for December 30th, 1916, will be found an article of special importance and interest to the engineering profession. It is entitled *On Stresses in Transparent Materials*, and considers a valuable method of investigating the nature and kind of distribution of stresses in engineering structures and machines. *Turtles, Terrapins and Tortoises of the United States* gives much interesting information in regard to a class of animals that have been generally overlooked both by the public and scientists, possibly because they are so familiar in appearance that it is taken for granted that we know all about them; which is far from the case. The article is elaborately illustrated by original photographs taken by the author from life. *The Synthesis of Caoutchouc* is a valuable survey of various attempts that have been made to produce artificial rubber, a subject that is constantly becoming of greater importance. A Government Department that is carrying on a work of inestimable value both to this country and to the world is the U. S. Coast and Geodetic Survey, conducted by the Department of Commerce. It is this department that, among other things, produces the splendid charts not only of our own coasts, but of many foreign ports frequented by our shipping; and although many are familiar with the appearance of these charts, few, even in the mercantile trades, have any idea of how they are constructed, and the immense amount of labor they entail. In the article *How Charts are Made* will be found an excellent non-technical description of the work, and it is accompanied by a large number of pictures illustrating the methods pursued, and the difficulties encountered. *Optical Appliances in Warfare* gives general descriptions of the many instruments made use of both on land and sea by the officers in charge, together with brief explanations of their construction and principles of operation. There are a number of explanatory diagrams. This issue of the SUPPLEMENT is of special value to all; the *Table of Contents* covers the past six months.

A Novel Use for a Motor Truck

MOTOR trucks equipped with steel flanged wheels for operating on rails have made it possible and practical for railroads and construction companies to salvage rails on abandoned spur lines and in construction camps where heretofore the cost of reclaiming the rails by other methods would not have warranted the work. The recent rapid rise in the price of steel has given an added impetus to railroads to investigate the practicability of motor trucks in this field and a test made at Nahant, Montana, in carrying out a contract for the Burlington Railroad, bespeaks the success of the trucks.

The railroad decided to salvage the rails on the abandoned McLaughlin lumber and tie road connecting the station at Nahant on the Burlington system in the Black Hills of Montana with the great forests 27 miles to the west. The McLaughlin Line had been abandoned several years ago on account of timber exhaustion and enforcement of the Forest Reserve Act, and when the job offered many obstacles. A locomotive could not be used to haul the rails because the forest reserve laws required oil-burning locomotives and the only ones available were wood burners. The track had not been kept in repair and the cost of putting it in shape to permit the use of a heavy locomotive would have been prohibitive. Another objectionable feature to the use of a locomotive was the rank growth of long and tough grass over the rails which in some places had grown to a height of 18 inches, weaving a network over the track that completely obstructed it from view.

After working on several schemes and later finding them impracticable, the contractors decided to test out a motor truck, which was equipped with flanges at the railroad's shops, shipped to Nahant and put to work.

In the first month the truck was in service it covered about 3,300 miles, averaging 108 miles a day and by the use of a flat car as a trailer, was able to haul 12 tons of rails into Nahant each trip. The truck made two round trips a day, climbing several grades as steep as 7 per cent on second and third gear and registering an economy record of better than 10 miles to a gallon of gasoline. After depositing its load at Nahant the truck covered the 27 miles to the forests on fourth speed.

Safe Fly Poisons

MESSRS. Phelps and Stevenson, of the U. S. Public Health Service, have been seeking substitutes for ordinary poisonous flypaper and other fly poisons, which, on account of containing arsenic, are more or less dangerous to human life and health. The best substitutes found were formaldehyde and sodium salicylate, which may be applied in a variety of ways.

To Our Subscribers

WE are at the close of another year—the seventy-second of the SCIENTIFIC AMERICAN's life. Since the subscription of many a subscriber expires, it will not be amiss to call attention to the fact that the sending of the paper will be discontinued if the subscription be not renewed. In order to avoid any interruption in the receipt of the paper, subscriptions should be renewed before the publication of the first issue of the new year.

To those who are not familiar with the SCIENTIFIC AMERICAN SUPPLEMENT a word may not be out of place. The SCIENTIFIC AMERICAN SUPPLEMENT contains articles too long for insertion in the SCIENTIFIC AMERICAN, as well as translations from foreign periodicals, the information contained in which would otherwise be inaccessible. By taking the SCIENTIFIC AMERICAN and SUPPLEMENT the subscriber receives the benefit of a reduction in the subscription price.

The Heavens in January, 1917

A Year of Seven Eclipses

By Prof. Henry Norris Russell, Ph.D.

THE year 1917 is remarkable for a very unusual occurrence. Within its limits there occur seven eclipses—four of the sun and three of the moon—which is the greatest possible number. To have five eclipses in a year is nothing unusual, nor is the occurrence of six very remarkable; but the last time that there were seven eclipses in a year was in 1805—more than a century ago—and there will be only two more years with as many eclipses occurring therein during the next century and a half.

Faced with so rare an event, it is worth our while to consider the why and wherefore of its occurrence. Everyone knows that eclipses occur when, and only when the earth, moon and sun—or at least parts of them—come exactly into line with one another. When the moon comes into line between the sun and the earth, we get an eclipse of the sun; when the earth comes into line between the sun and moon, her shadow falls on the moon and eclipses it.

Why then do we not get a lunar eclipse at every full moon and a solar eclipse at every new? Because the moon's orbit is inclined at an angle of about five degrees to the plane of the eclipse, in which the earth and sun move and, in consequence, she is in most parts of her orbit well above or below this plane, so that, at the full, she passes above or below the earth's shadow, and not through it, and, at new moon, escapes in a similar fashion from getting into line between the sun and the earth. There are, however, two points on the moon's orbit, called the nodes, at which she crosses the plane of the ecliptic from one side to the other. If new or full moon occurs when the moon is just at one of these points, she will be exactly in line with the centers of the earth and the sun, and, in the former case, her shadow will fall on the earth and produce a solar eclipse, while in the latter instance the moon herself will be totally immersed in the earth's shadow.

If the full moon—to consider lunar eclipses for the moment—disappears when the moon is a little at one side or the other of the node, she will pass a little above or below the center of the earth's shadow, but still be totally eclipsed. If the distance from the node is greater, she will only dip into the northern or southern edge of the shadow, and be partially eclipsed. Finally a limit will be reached beyond which there is no eclipse at all.

Very much the same thing happens in the case of eclipses of the sun, except that in this case it is the region of the earth's surface from which the eclipse is visible that alters its position, being near the equator if the eclipse takes place very near the node, and in high northern or southern latitudes if the distance from the node is near the limit.

Now the moon is new or full when she crosses a line drawn from the sun through the earth. There can therefore be an eclipse only when this line, which may be called the line of conjunctions, passes near the nodes. But this line of conjunctions follows the sun in its apparent motion around the ecliptic, completing a circuit every year. At some time in the first half of every year it will pass through the nodes (both at once, since they are on exactly opposite sides of the earth) and at the new moon or full moon, nearest this time we may look out for an eclipse. Then it moves away and no further eclipses can occur till about six months later, when the line of conjunctions has turned through 180 degrees, and come close to the nodes once more.

The eclipses of any given year come therefore on two definite eclipse seasons, about six months apart. If the nodes were fixed in position these seasons would be just six months apart, and always at the same time of year; but, as a matter of fact, the nodes themselves are slowly shifting their positions backward, and complete a revolution in about 19 years. They are therefore continually going to meet the line of conjunctions, so to speak—and consequently the intervals between eclipse seasons are on the average about ten days less than six months. Hence, if one eclipse season comes near the beginning of January, the next will fall at the end of June, and the following one late in December, but still in the same calendar year—so that there may be three eclipse seasons in one year, which is what happens this time.

We must consider how many eclipses there may be in any one eclipse season. This depemds upon the so-called "ecliptic limits" that is, the maximum distance between the line of conjunction and the node for which an eclipse is still possible. For an eclipse of the moon, this is found, when the necessary calculations are made, to correspond to the distance which the line of conjunction move in a little less than thirteen days.

Hence, if there is a full moon within thirteen days of the time when the line of conjunctions crossed over the nodes, there will probably be an eclipse. (If the interval is less than ten days there will certainly be one.)

Now successive full moons come about 29½ days apart. Hence if there is an eclipse at any full moon, the next full moon cannot possibly occur within 16½ days of the time when the line of conjunctions pass the node, and at this time there can be no eclipse. On the other hand if the moment just considered comes very near the middle of the twenty-ninth day interval, both the succeeding and following full moons may be outside the limit for eclipse. Hence there cannot be more than one eclipse of the moon in a given eclipse season. Usually there will be one; but more rarely there will not be any.

In the latter case, by the way, the new moon, coming about half way between the full moons, will come very near the node, and there will be a large eclipse of the sun.

The limits for solar eclipses are wider, for the reason that, to get a solar eclipse, it is sufficient that some part of the moon should conceal *some part* of the sun from some part of the earth, while for a lunar eclipse it is necessary that the earth should shut out the light of the *whole sun* from at least some part of the moon. It is easily found that there *may* be a solar eclipse if the moon is new within 18½ days of the time when the line of conjunctions passed through the nodes, and that there *must* be one if this interval is less than 15½ days. Since new moons come 29½ days apart, there must be one within 14¾ days of any assigned date whatever: and hence there must be one eclipse of the sun in each eclipse season. There may be two, if the time when the line of conjunctions passes through the nodes falls about midway between two new moons. In this case the two solar eclipses will be partial, and one will be visible in northern and the other in southern latitudes; and at the full moon between them, which will be very near the node, the moon will be totally eclipsed—thus making three eclipses altogether in one eclipse season.

This is what happens this year. In the first eclipse season there are three eclipses: Solar, partial, on December 24th, 1915; lunar, total, January 6th, 1916; solar, partial, January 23d, 1916. There are three, also, in the next eclipse season; solar, partial, June 19th; lunar, total, July 4th; solar, partial, July 18th. In the third eclipse season there are but two eclipses; solar, annular, December 14th; and lunar, total, December 28th; but both of these fall within the calendar year, giving seven eclipses in all, four of which are of the sun and three of the moon

This happened last in 1656 and 1787, and will occur again in 1982 and 2094. If the year had begun ten days earlier, the last eclipse would have been missed, but the eclipse of December 24th, 1914, would have come in at the beginning. So that there would still have been seven eclipses, five of the sun and two of the moon Such an arrangement actually occurred in 1805, and will happen again in 1935. It is, however, much rarer than the one first described, for the last occasion previous to 1805 was in 1255.

Oppolzer's great "Canon der Finsternisse" which gives particulars of all the eclipses from before 1000 B.C. to 2160 A.D., shows that in the interval between the Christian Era and the middle of the 22d Century, there have been or will be, 23 years with four solar and three lunar eclipses and nine with five solar and two lunar—so that, one way or the other, about one year in seventy has seven eclipses—though the actual intervals are very irregular, one being as long as 261 years.

Two of the seven eclipses of the year come in this month. The first, a total lunar eclipse on the night of January 6th and 7th, is well visible in the United States. The moon begins to enter the penumbra (the region in which part of the sun's light is cut off by the earth) at 11:35 P. M. Eastern standard time. She first meets the dark shadow at 12:50 A. M.; is wholly immersed in it at 2 A. M., and so remains until 3:29 A. M. She finally leaves the shadow at 4:39 A. M., and does not get clear of the penumbra till 5:53 A. M.

Though the morning hours are not altogether convenient times for star-gazing on a winter's night, the progress of the eclipse will be well worth watching

The solar eclipse on January 23d is invisible in this country. A considerable partial eclipse, amounting at most to nearly three-quarters of the sun's diameter, is visible throughout eastern Europe and and western Asia. In central Europe the sun rises eclipsed, and Spain, England and Norway will not see the eclipse at all.

At 11 o'clock: Jan. 7.
At 10½ o'clock: Jan. 14.
At 10 o'clock: Jan. 22.

At 9 o'clock: Feb. 6.
At 8½ o'clock: Feb. 14.
At 8 o'clock, Feb. 21.

At 9½ o'clock: Jan. 29.

NIGHT SKY: JANUARY AND FEBRUARY

The Heavens

Our map shows the position of the principal stars in the latter part of the evening. The great winter constellations are now "full south." Orion shines resplendent half-way up the sky. Above him, almost overhead, are Taurus and Gemini, and below the latter is Canis Minor. Canis Major, with the brilliant Sirius, is lower down, and below this again is the Ship Argo, whose brightest star, Canopus, surpassed only by Sirius, can be seen, low on the horizon, from points south of Virginia.

The southwestern sky filled by Cetus and Eridanus, is dull, but the northwest shows the conspicuous groups of Andromeda, Cassiopeia, Perseus and Auriga—the last practically overhead. Ursa Minor and Draco are low in the north, and Ursa Major is well up in the northeast. Leo and Hydra, in the east, complete the list of the more prominent constellations.

The Planets

Mercury is an evening star and well visible, early in the month, when he sets a little after 6 P. M. He is in Capricornus, far from any bright star, and is himself brighter than any star except Sirius, so that there should be no difficulty in identifying him. After a few days he draws in closer to the sun, and on the 19th he passes through inferior conjunction and becomes a morning star. By the end of the month he is visible again, rising about 6 A. M.

Venus is still a morning star, rising about 5:45 A. M. in the middle of the month, and not as conspicuous as she has been. On the 30th she is in conjunction with Mercury the two planets being about three degrees apart.

Mars is nominally an evening star, but is too near the sun to be observable. Jupiter is an quadrature with the sun the 17th and comes to the meridian at 6 o'clock in the evening.

Saturn is in Gemini, very favorably placed, being in opposition on the 17th, and visible all night long.

(*Concluded on page 599*)

The Recovery of Fibrous Material from Old Parchment Paper

By Dr. C. Bartsch

ORDINARY paper may be reconverted into pulp by passage through the kneading machine and boiling in water or diluted alkali solutions. But this is not the case with genuine parchment papers—so-called acid parchments—a stubborn fact which has long been a stumbling-block in the path of the paper manufacturer. This parchment remains entirely uninfluenced by boiling in water or diluted alkalis, and passing it through the kneader results merely in its being torn into tiny fragments which are entirely useless for the manufacture of paper. Should these fragments be worked up with ordinary old paper they would make their appearance unchanged in the surface of the finished product, rendering it wholly useless. On this account, in recovering fibre material from paper waste, all genuine parchment pieces must be carefully picked out ere the ordinary paper is subjected to the process of reconversion.

The resistance which this tough parchment paper offers to the process of fibre recovery is due to the presence of a certain chemical which unites and knits together the fibres during the process of parchmentization. This substance has always shown itself able to withstand any attempt to dissolve it out. Efforts at recovering the substance of such papers on an industrial basis succeeded only in converting the parchment paper into a fibrous slime, composed of innumerable minute bits of paper, which could only be used for filling. In no case was it possible to effect complete separation of the fibres from each other and in their entire length—something absolutely necessary if usable paper is to be produced.

It is now announced in Sweden that a process has been discovered by means of which all these obstacles may be overcome, and which will allow, at an extremely low cost, the reconversion of parchment papers into proper pulp with well-preserved fibres all completely separated from one another. A reagent has at last been found which will dissolve the troublesome ingredient without the slightest injury to the cellulose. The inner adhesion of the fibres is hereby overcome and the parchment paper reconverted in a large degree to its original state before being parchmentized, that is to say it is retransformed into ordinary paper. Parchment papers treated in this manner may without any further operations be converted into pulp by being passed through the kneader. The fibres will be found to be in an excellent condition and absolutely free and detached. This new process establishes the fact that the fibres are by no means profoundly affected by treatment with acid during the process of parchmentization, as has always been assumed, but that the conversion of the cellulose into the chemical substance is merely a superficial phenomenon which takes place chiefly in the outer layers of the sheet of paper.

The accompanying micro-photograph, which was made under official supervision at the request of the inventor, gives an excellent idea of the appearance of the fibres which had been recovered from a strongly parchmentized paper treated by his process. The period of time required for the operation of the reagent in effecting the dissolution of the parchment paper depends upon the strength of the solution used. It may be completed in a very short time; but for purposes of economy it will prove expedient to use a weaker solution requiring a somewhat longer immersion. The weaker solution, moreover, has the advantage that should the fibres be exposed unnecessarily long to the fluid they would in no way be injured. This permits the simultaneous treatment of papers of various thickness and degrees of parchmentization without damage to those most susceptible to the action of the fluid.

Micro-photograph of paper fibres as recovered by new process

Thoroughgoing experiments have proved the absolute efficacy of the process. The Royal Institute for Testing Materials has converted genuine parchment paper into fibrous pulp according to the prescribed formula and prepared papers not only from the recovered material entirely, but also with admixtures of other fibres—all with the greatest success.

The durability tests which the Institute has made prove that a most marketable paper of excellent quality may be manufactured from the recovered material with the addition of ordinary fibres. It is certain that after a little experience has been gained in the ordinary course of manufacture in factories strong papers could be produced with a still greater percentage of recovered fibre, and that it will be possible ultimately to make paper composed wholly of reworked fibres.

Both the papers produced from mixed as well as unmixed fibre material as recovered by this process were capable of being easily parchmentized and after undergoing this operation proved to possess a fine and even translucency and a tough "grip." The parchment paper fibres as liberated by this process are pure white and may therefore be utilized for the manufacture of white papers.

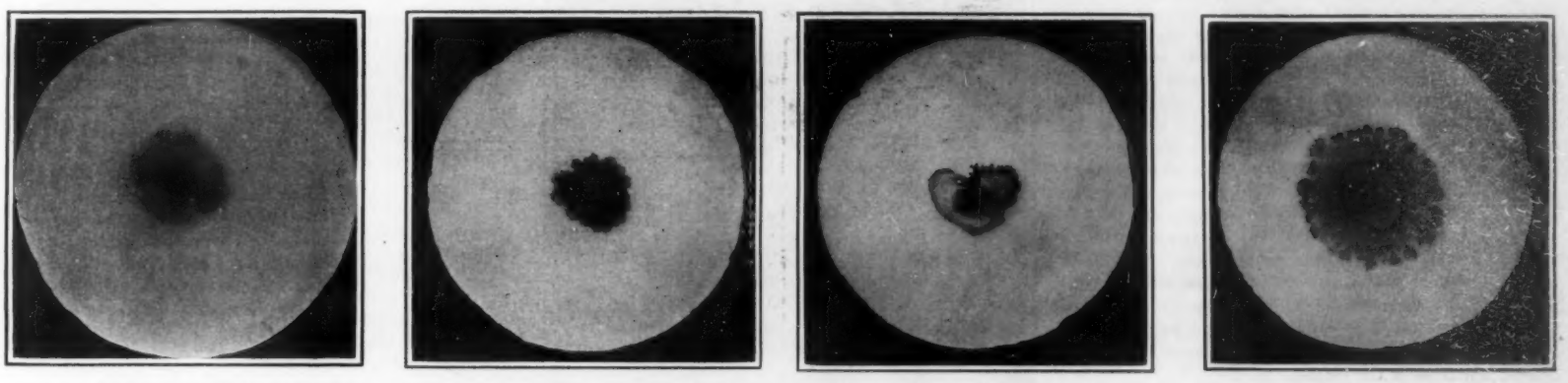
The new discovery will prove of the utmost value in a commercial sense as it constitutes a great saving in the cost of the raw materials for paper manufacture. The enormous quantities of parchment papers which had hitherto gone absolutely to waste may now be utilized at considerable profit. The invention possesses a particular interest for America, where parchment papers, as is well known, are not so heavily impregnated as those made abroad, and may therefore be reconverted still more easily and cheaply.

A Strange Botanical Garden

By James Anderson

PERHAPS the most remarkable miniature botanical garden in the United States is to be found in one of the tower rooms of the American Museum of Natural History, New York. All the casual visitor would notice, in this strange garden, would be, instead of the ordinary rows of flower beds, rows and rows of test tubes in neatly arranged and classified wooden racks. A somewhat closer inspection would show in each tube a sort of jelly. On the slanting surface of the jelly is what looks like a smear of whitish paste in some tubes, while in others the paste is more abundant and yellowish and in still others it looks like a wrinkled mass of moist brown paper. The smear, or the wrinkled mass, in each case is a growth of microbes, millions of them; and the collection is a garden of living germs.

These minutest of plants need careful tending. Most of them grow on a jelly made up with meat, peptone, and the extract from a Japanese seaweed, agar. Some, however, require very special foods, as variously and exactly compounded as those that are prepared in the diet kitchen of a hospital. Some must have egg; some, blood; some, milk; some, salts of special kinds. Some need air while others must be cultivated in tubes from which oxygen has been removed by special chemical means. Some will live for weeks without attention, while others must be transferred to a fresh tube of food jelly every three days. A laboratory helper is busy all the time preparing the culture media for these small but exacting plants, while the bacteriologist in charge is quite fully occupied in transferring them, at the proper time, by touching the old group with the tip of a platinum needle, which carries an invisible but potent speck of bacteria to the new tube.



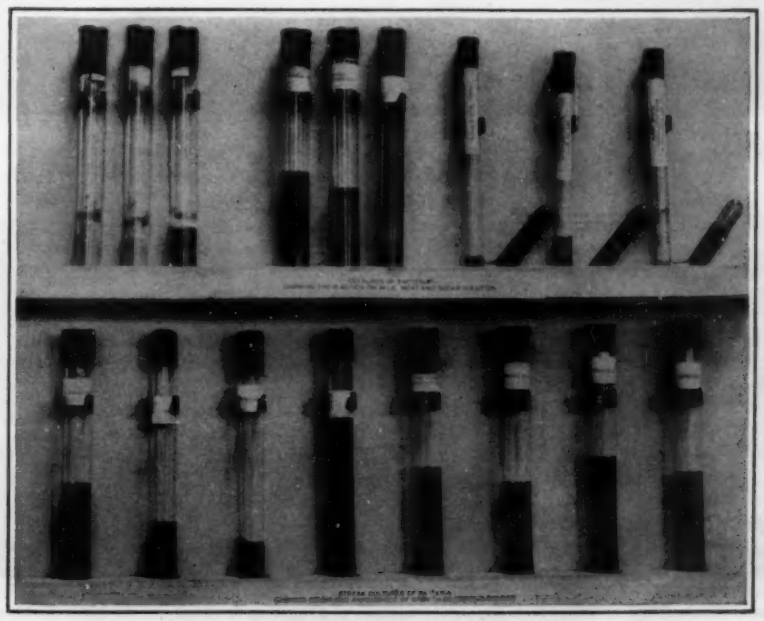
Four colonies of living bacteria. The second one from the right is the nitrogen-fixing bacterium of the soil; the others are all less important varieties

Some of the plants—the typhoid bacillus, for example—are so small that 400,000,000 could be packed into a grain of granulated sugar.

This strange Botanical Garden might at first sight seem out of place in a Museum of Natural History. But the museum directors think that bacteria, the most potent living creatures on the earth, fall within the field of Natural History as truly as whale or dinosaur, redwood tree or elephant. Indeed, the relationship between microbes and the higher plants and animals are so many that this group is of peculiar interest. Their activities in changing decomposing organic matter into forms suitable for the food of green plants, in fixing the nitrogen of the air and rendering it available for utilization, lie at the very foundation of all agriculture. Bacteria not only cause manifold diseases of plants and animals, but are also the active agents in the decay of foods and other organic compounds; while on the other hand they ripen our butter and cheese, make vinegar and lactic acid, and aid us in a score of other arts and industries. Yet these smallest and most abundant of living things have never heretofore been honored with the recognition of Museum authorities.

There are about seven hundred different plants in the Museum's garden of germs, representing practically all known types. Bubonic plague has alone been excluded, on account of accidents which have oc-

(Concluded on page 599)



A flower-bed from the Natural History Museum

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes and Trademarks

Electric Stevedores in the Modern Lumber Yard

EVEN the lumber dealer has now learned what is already well known in many modern industries namely, that manual labor is the most expensive form of work; and so he expresses himself by employing electric motors for loading lumber onto motor trucks and wagons.

Out in Newark, N. J., a large lumber dealer finds it economical and expeditious to employ a number of electrically-operated cranes of simple design for loading purposes. These cranes, which appear in the accompanying illustration, are operated by an electric motor housed in a waterproof casing just below the boom. Standing below the motor box, the operator controls the loading operations by means of two ropes hanging down from the box and terminating in suitable handles. Thus it is possible for one man to handle a number of pieces of lumber at once and in far less time than would be required by several men.

These simple derricks, operated by electric motors, save much time and labor in the modern lumber yard

Protection for the Fire Fighter

NO longer will the fear of being overcome by poisonous gases or struck on the head by falling objects be entertained in the minds of the Cincinnati firemen, for they have been equipped with a new oxygen helmet of the very latest type. Natural air is supplied from a tank in the rear of the helmets, while an ordinary air pump is used to put two hundred pounds of pressure in the tank before use. The air flows out of the tube in front of the fireman's nose, and inhaled air is forced out by the new air through lamb's wool pads on the shoulders. Special telephone ear-pieces on the sides of the helmet make it possible for the wearer to hear commands. The glass visors may be cleaned by turning a button.

The helmets are reinforced on top to withstand blows such as would be received from falling bricks, etc. There is room enough to keep the top of the helmet from coming down on the fireman's head when it is struck. To give the fireman a chance to call for help in case of trouble he is equipped with a little whistle, blown by an air bulb on the front of the helmet.

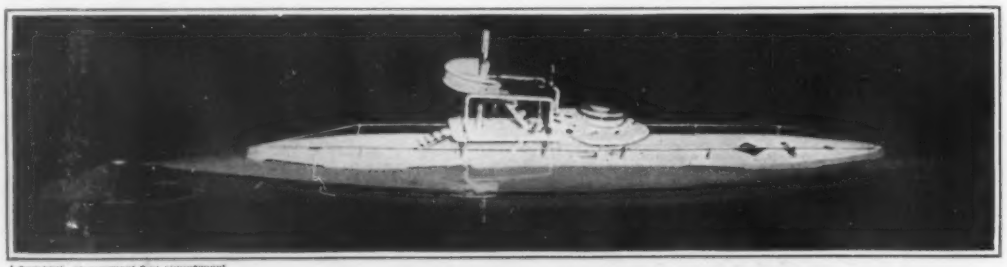
These helmets were put through a very strenuous test, and proved that they will be of unlimited value to the fire department.

A gas mask for the peaceful purpose of fighting fire

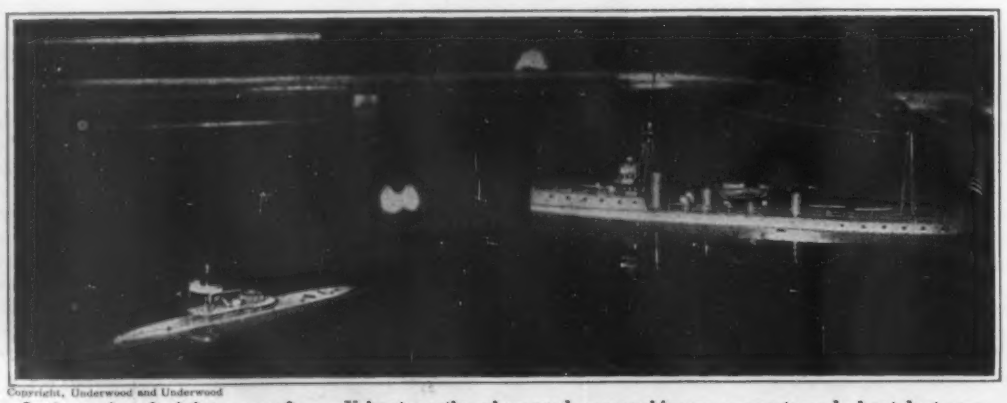
A Toy Submarine that Submerges During Its Journey

THE European war is much in evidence in the offerings of the toy manufacturers this year, for there is practically no end to such martial toys as tiny howitzers mounted on caterpillar wheels, scout planes, field guns, machine guns with wooden bullets fed into them on a canvas belt, battleships, and, most recent of all, a model U-boat which emulates to a considerable degree the maneuvers of the German submarines.

Action, which seems to be the predominate note in the military toys of the present, is not lacking in the miniature U-boat. This little craft, built in several different sizes, is propelled by a clockwork mechanism by a single screw, and it can be steered by means of a propeller. But the unique feature is to be found in the submerging apparatus, consisting of deflecting planes at the rear of the hull, which are controlled by clockwork. Before the U-boat is started on its journey, the diving mechanism is adjusted to conform with the desires of the juvenile commander. The journey begins: The craft glides on the surface of the water for a few feet, when the deflecting planes are automatically tilted at the proper angle and the nose of the submarine dips down until only the periscope is visible above the surface. The submarine continues for some length of time below the surface until the clockwork again tilts the planes, bringing the craft back to the surface. The U-boat can be made to dive as far its weight permits it to.



First riding on the surface, then plunging below, and coming up again, this model submarine affords much pleasure to youngsters



In the realm of miniature warfare: U-boat, partly submerged, approaching an enemy torpedo-boat destroyer

Twine from Paper

THAT wrapping twines which give thorough satisfaction can be made from paper has been demonstrated by experiments made by the Forest Products Laboratory at Madison, Wis. Several hundred packages, each containing a medium-sized book, were wrapped and fastened with the lightest-weight paper twine and were mailed to various points throughout the United States. Reports show that practically every package was received in good order and that in no case was there any damage which could be charged as a fault of the twine.

In making twine the paper is cut into narrow strips which are then twisted tightly to form a cord. The strength of the twine depends upon the character of the paper used and the process of treatment. It is well adapted to a number of purposes, but the foresters say that as yet no satisfactory means has been found for protecting paper twine from the action of water and it should not be used where it will be exposed to moisture.

Melting Chinese Brass Coins for Their Copper Content

A SERIOUS situation in Chinese monetary matters is being developed by the export from China, particularly to Japan, of Chinese brass "cash," the characteristic coins with square holes in the center that have been the basis of trade in the interior of China for many generations. The rise in the price of copper has rendered these brass coins, which usually contain about 89 per cent of copper, more valuable as metal than as a medium of exchange.

For a time over 6,000 tons of the coins were exported monthly to Japan alone. A fall in the price of copper reduced shipments to about half this quantity, but the export continues and now at various points in the interior of China the number of cash in circulation is far below the requirements of the people, and difficulty is being experienced in carrying on ordinary trade. In parts of South China, Chinese one-cent pieces now exchange for only five cash, instead of ten cash that usually is considered a standard rate of exchange. The cash have been bringing about $25 local currency, or something like $12.50 gold, per picul of 133-⅓ pounds. In Japan they have been valued at the equivalent of $15 gold. Japanese newspapers report that the refined copper is being exported to the United States.

The business of buying up and melting these coins has been so large and so profitable that a monopoly thereof was one of the considerations proposed for a recent Chino-Japanese loan. The fact that a single Japanese firm is in the market for 3,000,000 piculs (200,000 short tons), indicates something of the enormous quantity of such coins in China. At the same time the monetary requirements of a vast population like that of China are in proportion, and the melting up of such coins disturbs the balance of supply and demand. The first effect will be to increase prices locally in terms of cash—the medium on which Chinese production of goods for export primarily is based—and it is likely therefore to have a marked effect on foreign exports.

We can well imagine the hostility engendered should foreigners attempt to corner for commercial use coins of the United States; yet China has only just awakened.

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A Strange Botanical Garden

(*Concluded from page 597*)

curred in other laboratories with this peculiarly deadly germ. Typhoid and diphtheria germs, however, are to be found, with those of whooping cough and cholera, meningitis and leprosy, influenza and pneumonia. In the collection are also the bacteria which cause plant diseases and those which decompose foods. There are strains of the Bulgarian bacillus which makes buttermilk and the lactic acid bacteria utilized by the tanner. One germ that infects sugar cane came from Louisiana and another was found fixing nitrogen in the soil of a bean field in the Middle West.

The keeping of records incident to the maintenance of this strange garden is in itself no light task. For each of the nearly seven hundred plants there is a history card with a serial number on which every single transfer to a fresh tube is entered, with the date and the initials of the bacteriologist, so that one can tell at a glance exactly what has happened to each plant since it was added to the collection.

One of the most interesting things about the garden is the rapidity of the growth of the plants. When a single microbe is planted in a suitable jelly medium, it will grow and divide again and again (under favorable conditions once in twenty minutes), till in a few days or weeks there will be a colony, perhaps half an inch across, a city of millions of descendants of the original germ, and of characteristic form, texture, and color.

The main object of the garden of germs is to furnish standard types for the use of teachers and investigators throughout the country. It has been the policy of the Museum to distribute subcultures from its strains as widely as possible to all responsible persons and in all cases without charge. Disease germs are, of course, carefully guarded, being sent only to laboratories of known standing so that they may not get into the hands of unauthorized persons, while special "teaching sets" of typical non-pathogenic forms are sent to the smaller colleges and normal schools for use in class work.

Last year nearly thirty-five hundred cultures were sent out to over four hundred different institutions. Every university and health department of importance in the field of bacteriological teaching or research in the United States or Canada depends upon the Museum garden at the present time; and cultures have been sent to Cuba, to Austria, to England, and to South Africa.

The Heavens in January, 1917

(*Concluded from page 596*)

Uranus is an evening star, but too near the sun to be observed. Neptune comes in opposition on the 23d, and is easily observable with a telescope, though invisible to the naked eye. He may be distinguished from the faint stars near him by his greenish color, and especially by his westward motion. On the 3d he is in 8h. 25m. 20s. right ascension, and declination 19° 1′ north, while his position on the 31st is 8h. 22m. 9s. +19° 12′.

The moon is full at 3 A. M. on the 8th, in her last quarter at 7 A. M. on the 10th, new at 3 A. M. on the 23d, and in her first quarter at 8 P. M. on the 29th. She is nearest us on the 23d and farthest away on the 10th. During the month she passes near Jupiter on the 1st, Saturn on the 8th, Neptune on the 9th, Venus on the 21st, Mercury on the 22d, Mars on the 23d, Uranus on the 24th and Jupiter again on the 29th.

A faint comet, visible only with large telescopes, was discovered by the Rev. J. H. Metcalf upon a photograph taken by him on November 21st. On the 26th of November it was in right ascension 3h. 34m. 24s. and declination +15° 23′, and was moving about 43s. westward and 36′ southward per day. Very few observations have come to hand; probably on account of its faintness, and its orbit is not yet determined.

Princeton University Observatory
December 8, 1916.

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Note.—Illustrated articles are marked with an asterisk (*). Look for the general subject rather than the supposed specific titles of articles. Thus: "Aeronautics," "Automobiles," "Meteorology," "Panama Canal," etc., will give related articles much more quickly than by reference to the title.

(Concluded on page 602)

Inoculating the Mortgage-Lifters

(Concluded from page 591)

ually extended to all portions of the United States along lines of transportation.

Hog cholera mortality is 100 per cent in some herds, while the average is probably from 70 to 80 per cent. Hogs which survive are usually worthless. There is no cure for hog cholera. But it is preventable, and by a method which will ring naturally in ears accumstomed to hear of preventive serum for human diseases. Starting with the fact that hogs which recover are thereafter immune, the Bureau discovered that an immune, injected with blood from a sick hog, can provide blood which will protect other hogs.

The process is scientific and exact and its results wonderful. A vigorous immune hog is treated with much blood from a hog cholera patient. After a week or two blood is drawn from the immune by cutting off the end of the tail. The fluid portion of the blood is mixed with weak carbolic acid, forming the serum which protects from hog cholera. It is used either by simple or by simultaneous inoculation.

In the first method an injection of serum alone is made inside the hind leg. This protects from hog cholera for several weeks. If not exposed to hog cholera the immunity gradually lessens in degree and the hog may again become susceptible. If, however, the hog is exposed to hog cholera within a short time after the injection of the serum, the immunity becomes of lifelong duration. In simultaneous inoculation the same serum is used but there is also injected a small quantity of blood taken from a hog cholera patient. This confers a permanent immunity.

So much for the facts. Now for the results. We give the figures of the Bureau of Animal Industry. Of the sick members of infected herds treated by the Bureau's agents during three years, 28.8 per cent died; of the well members, the mortality was 4.5 per cent among those treated by serum alone, and 3.7 per cent among those enjoying simultaneous treatment. These results are indeed marvelous.

Hog cholera work is by no means confined to serum treatment. Close study of 738 cases showed that only 177 came from indefinite causes. The rest were directly traceable to some source, often preventable. One hundred and forty-five cases were traced to birds, 110 to visiting infected premises, 89 to exchanging work with infected farms, 52 to dogs, 50 to exposure of well hogs to sick ones in adjoining pens or pastures, 41 to infection harbored from previous sickness, 10 to polluted streams, 30 to purchase of new stock and 4 to infection on cars.

From an examination of these and other causes of hog cholera, a simple set of preventive rules has been evolved. Farmers in whose neighborhood hog cholera exists are advised to follow implicitly these rules, which consist in nothing else than the application of commonsense methods of preventing the operation of the causes enumerated, and in the adoption of decent sanitation in the homes of the pigs. The latter requirement may well be emphasized, in view of the still wide prevalence of the good old fashioned notion that a pig is a creature of filth anyhow, and will flourish only in filth. Nothing could be further from the truth.

These methods, together with serum treatment, have greatly reduced the economic loss, but the ideal of the Bureau is the complete eradication of the disease. To this end, at the present time intensive hog cholera work is being conducted in 130 counties in thirteen states, with a view to the eradication of the disease in restricted areas.

The system is to select a definite territory in each State, assign competent Bureau veterinarians to such territories, who coöperate with State authorities. Because the disease is so highly infectious and incurable, the important part of the work is one of prevention. Special stress is laid on the importance of sanitation, guarding against introduction of infection, and the better care of swine in general. The facilities of the Bureau are available whenever hog cholera is prevalent.

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NINETEENTH ANNUAL

MOTOR NUMBER

of the

SCIENTIFIC AMERICAN

January 6, 1917

The SCIENTIFIC AMERICAN can justly claim to be the oldest automobile journal. It started writing the history of the motor car in 1845 and has consistently kept pace with the progress of the power-driven vehicle ever since. A review of the early days of the automobile, profusely illustrated with quaint cuts from the files of the SCIENTIFIC AMERICAN will be published in our Motor Number.

Although this will be our *nineteenth* annual Motor Number the subject has been by no means exhausted. Recent progress in the automobile industries has been simply stupendous. We are sure that our readers will be astonished at the number of cars now in use and the large proportion of the total represented by cars purchased during the past year. Public endorsement of the automobile, as represented by the amount of money invested during 1916 in the purchase and operation of motor cars, is startling. The figures are so vast that we have shown them in the form of a graphic comparison which will enable the mind to grasp them.

Following the usual custom, there will be an article on the pleasure car of 1917. An expert will dissect the car and point out the improvements and novel features. In a companion article the commercial car of 1917 will be described minutely in this SCIENTIFIC AMERICAN way.

The Bureau of Standards has recently been investigating gasoline pumps and has found that many of these pumps do not deliver full measure. The trouble is not always due to dishonesty, but is very often attributable to faulty design. An illustrated article on this subject has been prepared for our Motor Number, which gives the construction of various forms of pumps, placing the motorist on his guard, and showing him where to look for faulty design or dishonesty.

Motorists will be interested to know just what work is now being done, or what is proposed to be done in the immediate future, toward the betterment of roads under the new law which provides for Federal aid. It has probably not occurred to the general public that not only does the automobile make for good roads, but good roads increase the number of automobiles in a State. Some interesting statistics have been prepared on this subject.

"Attacking the Motor's Mightiest Enemy" is the title of a very interesting article by an automobile engineer. It deals with the problem of getting rid of carbon accumulations, in the most efficacious way.

The latest automobile novelties and accessories will be shown in a double page spread of pictorial notes.

As in previous Motor Numbers, there will be the usual charts of gasoline and electric pleasure and commercial vehicles, in which the names of manufacturers and the prices of cars will be given. The material will be arranged in such form as to constitute a valuable price list and reference table for prospective purchasers of motor vehicles.

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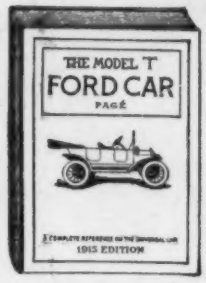

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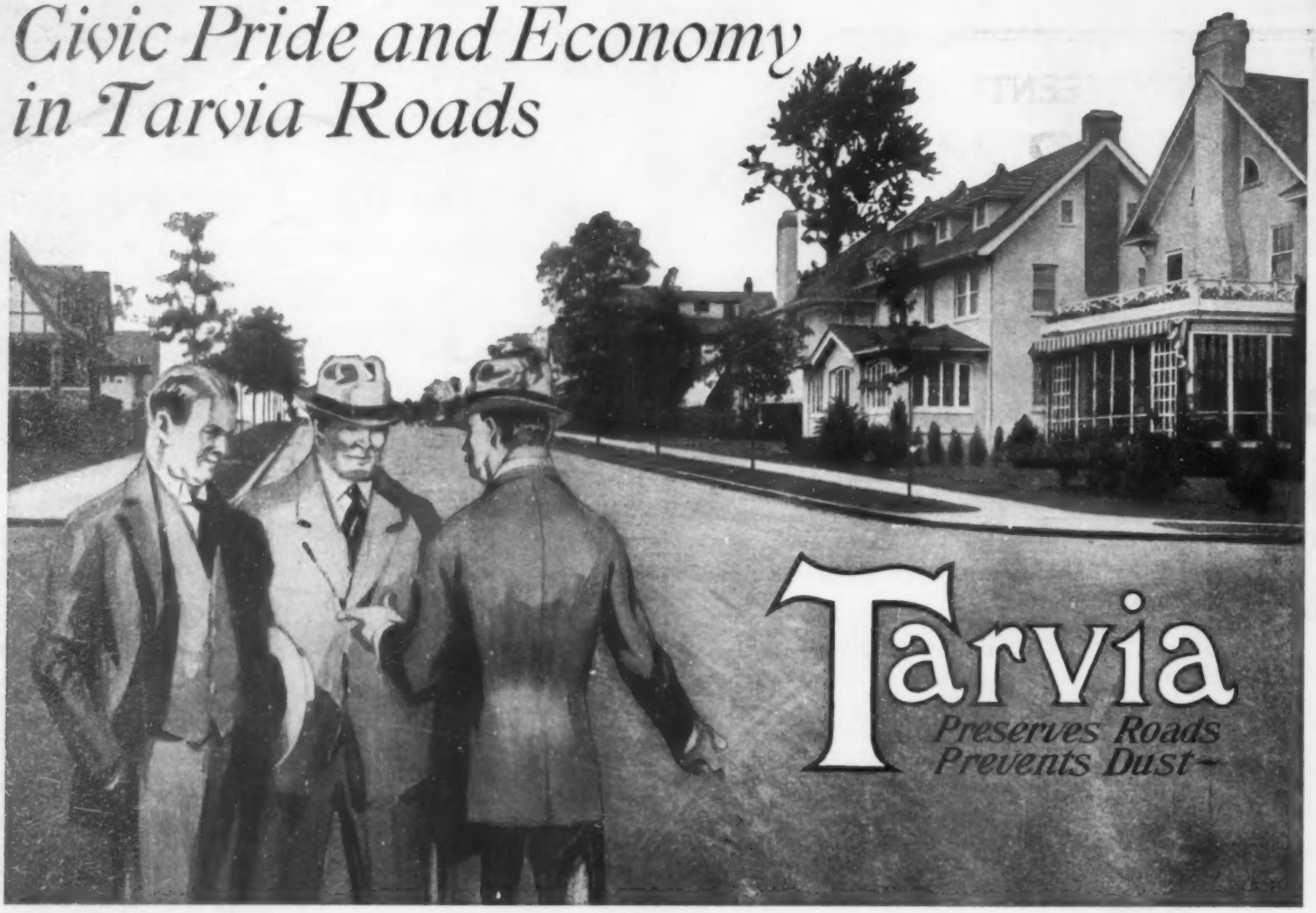

Street in Kew Gardens, Borough of Queens, New York City. Constructed with "Tarvia-X", Penetration Method, in 1914. Treated with "Tarvia-B" in 1915.

HERE'S a group of citizens in a certain progressive town. They own cars, vehicles, horses —and they are taxpayers.

For their business and pleasure, they have wanted smooth, dustless and mudless streets.

They've got them now—*because their roads are being built and treated with Tarvia.*

They are very proud of the result. Tarvia has made their streets smooth as a dancing-floor, and so dustless that there's no more use for the watering cart, and the streets are free from mud as well.

What pleases them most, *as taxpayers,* is the fact that the use of Tarvia is really an economy—not an expense.

Its use adds years to the life of the road and it saves so much in maintenance expense, that in the long run it reduces road taxes.

The only maintenance required is an occasional coating of Tarvia spread on when the road begins to show wear. Such treatment is very inexpensive.

What Tarvia Is

Tarvia is a coal tar preparation, shipped in barrels or tank cars. It is made in three grades, to be used according to road conditions, viz.: "Tarvia-X," "Tarvia-A," "Tarvia-B." The chief use of Tarvia is for constructing and treating macadam roads,—to make them durable, smooth, resilient, dustless, mudless, waterproof.

It is also used on concrete roads, on brick pavements and even on good gravel roads,—to smooth out irregularities, to arrest disintegration, and for repairs.

"Tarvia-X"

is always to be used when you are building a new macadam road both as a binder and surface coating. The old way in building macadam was to use water as a binder.

But a water-bound macadam wears out quickly under the prying strain of the automobile driving-wheels and the horses' hoofs.

Results of "Tarvia-X"

With a tarvia-road in place of water-bound macadam, you have a road smooth enough to dance on, resilient enough for rubber tires to grip on without skidding, or for horses to trot on without slipping, without dust in dry weather, without slime in wet weather. You have a road that lasts.

"Tarvia-A"

is practically a thin "Tarvia-X," used for recoating the surface of a macadam road already built. It is applied hot and adds greatly to the life of the road. It keeps the road smooth, dustless and inviting to traffic, but its use is confined to certain kinds of traffic to be economical.

"Tarvia-B"

is a much more widely used preservative. It is applied cold. It is thin enough to sink quickly into the road, yet strong enough to bind the surface particles together into a dustless durable surface.

"Tarvia-B" offers the lowest cost of road maintenance yet invented.

It can be used effectively for repairing and preserving macadam roads under varying conditions of traffic and situation. It may even be used effectively on certain classes of gravel, shell and adobe roads.

Booklets describing the Tarvia treatments free on request.

Special Service Department

In order to bring the facts before taxpayers as well as road authorities, The Barrett Company has organized a Special Service Department, which keeps up to the minute on all road problems. If you will write to our nearest office regarding road conditions or problems in your vicinity, the matter will have the prompt attention of experienced engineers. This service is free for the asking.

If you want *better roads* and *lower taxes,* this Department can greatly assist you.

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